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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

You will find the pages of the ELECTRICAL REVIEW full of varied interest this week. He is the wise electrician who has its weekly visits form part of his vacation enjoyment.

The usual vacation season has not been much in evidence this year in the electrical industry. While a few branches have fallen off in business, the bulk of the demand for electrical products has so far continued through the summer.

ENGINEERING RESEARCH.

The various technical laboratories seem to be losing a great opportunity to add to engineering knowledge. Some years ago it was proposed by the American Institute of Electrical Engineers that engineering colleges coordinate their research work, and as an aid to this end a list of subjects suitable for theses was proposed and published. The returns from this plan have not been as large as could be desired. It is true that a number of contributions on technical and scientific subjects have been made which were doubtless results of studies suggested by the Institute circular, but if all the colleges had adopted this plan the results would have been greater.

There is in this connection one thing that should be recognized. The results of much of the research work done in technical laboratories never get out. As usually turned in, they are in the form of theses, which are not suitable for publication, not having been written with this end in view. It would seem that, if the instructors in these laboratories could find the requisite time to sift out and edit such theses and other work as seems of value, and either present it to some suitable association or publish it in the technical journals, a great deal would be accomplished. While doubtless much of this work is not strictly original, the data thus obtained would help to verify other work done along the same lines, and in this way would be of great value to the profession.

Another point germane to this subject, and which will account for the lack of published results, is this: The usual topic selected for a thesis investigated by the undergraduate is much too comprehensive. The natural result is a large amount of work is laid out and a great deal of time put in in general investigation, but no definite conclusions are reached, the time allowed being too limited. If a small part of the subject had been selected and the entire time had been spent upon this work and it had been pushed to a conclusion, the results would have been more satisfactory to the students themselves and of more value to the profession. The experience would certainly have been as valuable as more benefit would accrue from the training given by carefully conducted and exhaustive study of some definite phenomena or effect than from the same amount of time put in in a general research which covered a wide field and reached no definite results in the end.

ELECTRIC DRIVING IN THE NAVY YARDS.

While electric driving has been adopted in the Washington Navy Yard to some extent, one shop having individual motors, there is still room for an extension in this regard. Indeed, there would seem to be no good reason why every large tool, possibly every small tool, in all the shops, should not be driven electrically. The secondary advantage of cleanliness and flexibility may have some weight in the navy yard, but the all-important question is the ability to rush work. In this respect no other method can be compared with the individual electric drive. Its overload capacity and the ease with which the speed can be changed to secure the best results and quickest work make it especially desirable in this plant.

There is no security so great as that ability in the event of any unpleasantness. The side which strikes first and strikes hard is apt to retain the upper hand. To secure these desirable advantages the navy yards should be equipped throughout with the latest and best tools driven by the best and most reliable system. Here the question of first cost is of slight importance. The sole aim should be to give the maximum output of the best material in the minimum time.

JOHN W. MACKAY.

The passing of Mr. John W. Mackay, financier and philanthropist, marks an epoch in the history of electric telegraph enterprises. Through his identification with the Commercial Cable Company and the Postal Telegraph Company, his name has become familiar as a household word to the people of Europe and America. It was his vigorous prosecution of what at one time seemed to be a hopeless cause, that developed the magnificent institutions with which his name is connected, and, taking no small part in the latest and most far-reaching development of Pacific cable enterprises, an international affair, he has been stricken within a very short time of the completion of arrangements for its carrying out.

Although born in Dublin, in 1831, Mr. Mackay spent nearly all of his life in America, and may be regarded as a typical citizen in every respect. His boyhood days were passed in the near vicinity to where the great building, containing the offices he so lately occupied, is reared. Not only in the development of the electric telegraph and cable enterprises was Mr. Mackay deeply interested. The interests which he held were numerous, and in every condition of affairs his rare executive ability and broad views have had a marked effect upon their utility.

Mr. Mackay's reputation, while being preeminent in Europe and America, was of world-wide acknowledgment. Upon receipt of the news of his death in the United States, the offices connected with his company throughout the nation were thrown into the deepest mourning. In London a memorial service was held immediately, and during the week just passed a solemn requiem mass was celebrated at St. Mary's Roman Catholic Church, in London, a large assemblage of the most prominent persons in the city being present. A mass was also celebrated at St. Leo's Roman Catholic Church, New York city, a large number of business and social friends of Mr. Mackay attending the service.

The great work so splendidly carried forward by Mr. Mackay will not stop with his demise. While the place of a great and good man is always hard to fill, it is well known that the excellent foresight which he possessed, particularly in selecting able associates, has made it possible for that which would have pleased him most in life to be accomplished now that he has gone.

ELECTRICITY FOR THE NEW YORK CENTRAL.

The announcement by the officials of the New York Central Railroad that electricity is to be adopted for moving the trains through the Park avenue tunnel and the suburbs of New York city will be read with gratification and pleasure by every one.

There can be no question but that this decision is an eminently wise one. No doubt exists as to the success of this change, as the method has been thoroughly tested.

The officials of the New York Central are to be commended upon their choice, and the patrons of the road are to be congratulated upon the prospect of soon enjoying the benefits of this best method of transportation.

THE STEAM TURBINE.

The necessity of securing a uniform speed of rotation in our prime movers is becoming one of the most important problems in central station design. As long as continuous-current systems are able to supply the district there is no trouble whatever from irregularity of rotation, as the momentary increase in speed of any one generator simply causes it to pick up a little more of the load without affecting the voltage of the system. This fault, if indeed it can be considered as of sufficient importance to be called a fault, is self-correcting, for the machine which tends to speed up is held down by the increase in its load while the others tend to speed up, their loads being decreased. The result is an automatic balancing of the load between the generators.

In the early alternating plants of this country few attempts were made to operate the generators in parallel. The switchboard was arranged so that each machine took care of certain districts. To make the system flexible it was necessary to build a complicated switchboard with a multiplicity of switches, by the proper manipulation of which the various feeders could be thrown on different machines. In a large station either the switchboard became very complex or the flexibility of the system was quite limited.

In our large modern stations it has long since become necessary to run all the generators in parallel, to secure economic operation, and to give a desirably simple and flexible plant. This method of operation, however, has brought its troubles. When alternators are driven by reciprocating engines in which perfect uniformity of rotation can not be secured, the station engineer makes the best of this condition by calling for an engine with as small an angular variation in speed as can be guaranteed. To secure this a heavy design is necessary, a large flywheel must be added and the engine made with two or three cranks. Only in this way can the heavy cross-currents, which would be set up by non-uniformity of rotation, and which would cause annoying fluctuations in voltage, if nothing worse, be prevented.

However, these means of securing uniformity of rotation are not without their disadvantages. Large machines can be placed only in large rooms, and heavy vibrating machinery needs costly foundations, two items of considerable importance in large city plants which usually seek the waterside.

Now it seems strange that the only class of prime mover operating by steam which gives an almost absolutely uniform rotation and which does not have the disadvantages noted above, should not have had a wider application. This may be explained, however, by the fact that while makers of this class of engine were not ready to push it, neither was the station engineer altogether convinced that this going back to apparently primitive methods would solve the problem. The early forms of steam turbine were far from being economic machines, and it remained for the builder, not only to determine the proper method of utilizing the steam, but to design a suitable machine, and further to demonstrate the efficiency and durability of this motor, before the engineer would be warranted

in recommending it in place of the thoroughly understood reciprocating engine.

It seems to-day as if this had been done. The modern steam turbine is a wonderfully simple machine. Its efficiency is equal to that of the best compound condensing engine. It occupies little space, needs little or no foundations and runs with a minimum of attention.

If these points be admitted, we may expect to see the use of the turbine in our large power stations and isolated plants grow rapidly within the next few years.

ELECTRICAL FIRE HAZARDS.

Despite the often demonstrated fact that the number of fires started from electrical causes is small compared to those due to other sources of light and power, there seems to be a decided prejudice in insurance circles against this form of energy. Complaint has been received recently that when a large paper manufacturer desired to introduce electric lighting into his works, replacing about five hundred gas lights by an equal number of incandescent lamps, the insurance companies notified him that this change would involve an increase in his rate.

In an endeavor to account for this by a search through the electrical code of the National Board of Fire Underwriters, the following special rule was found (p. 27, edition of 1901):

24. WIRES— . . . For open work in damp places, such as breweries, packing houses, stables, . . . paper or pulp mills, or buildings specially liable to moisture or acid, or other fumes liable to injure the wires or their insulation, except where used for pendents. . . .

i. Must have a perfect rubber insulated covering. . . .

j. Must be rigidly supported on non-combustible non-absorptive insulators. . . .

k. Must have no joints or splices.

These rules are not only dictated by common sense, but are easily complied with, and there should be no difficulty whatever in satisfying the most exacting inspector in this respect.

On page 66 of the July issue of *Insurance Engineering,* in discussing the "Maintenance of Electrical Hazards," the editor says: "There is very little doubt, however, but that electricity is the best, if not the safest, form of energy yet discovered for illumination or power, if installed according to the rulings of the 'Code,' and also providing some care and attention be paid to the matter of maintenance."

Taking this opinion of an editor, who is certainly competent to pass judgment, in connection with the underwriters' rules noted above we fail to understand the position taken by the insurance companies. Electrical energy is acknowledged to be the safest form if properly installed. The underwriters have the making of the rules and one would naturally assume these to be sufficient. If they are not sufficient, it is the place of the fire underwriters to draw up rules, no matter how stringent, which will satisfy the insurance companies. It is for the owner of the factory to choose his system of lighting. If he does not care to go to the additional expense which more stringent rules might involve, let him pay a higher rate. But to publish rules which, when followed, do not meet the requirements of the insurance companies certainly savors of a prejudice against electrical installations for lighting and power for which no good reason has been given.

In the case cited five hundred gas jets were to be replaced by an equal number of incandescent lamps, doing away with the use of all matches and open flames. It is difficult to imagine a case where electric lighting would be more desirable, yet the proprietor is practically to be fined if he takes this step to improve his lighting and protect his factory.

Wireless telegraphy continues to be an interesting topic of discussion, and inventors of new systems in this important field are being heard from on many sides. It seems to be the history of every important discovery in the sciences and arts that many minds, in widely separated parts of the world, are found to be working out the same problem, which some fortunate one is the first to announce. We expect to see much additional development yet in the wireless telegraph field, and the bearing it may have on the transmission of signals and power of the future would be difficult to forecast to-day, but certainly possesses a fascinating and expanding mental vision of what is to come.

RAILWAY MOTORS.

Probably but few of us realize fully the character of the work performed by the humble railway motor. We have become so accustomed to this mode of transportation that we naturally expect to find the cars moving day and night, in wet weather and dry, without giving a thought to the operating mechanism.

When the problem of an electric traction was first presented, the conditions were very different from those to-day, and the solution reached along somewhat different lines from those in which it would now be attacked.

A realization of the complexity of the problem as presented, and of the completeness of the solution, may be brought about by a consideration of the conflicting conditions which must be provided for. The first consideration is reliability. We must have a motor which is always ready for work. Ordinarily, this would point toward an open design, with every part easily accessible, the generous use of material and ample ventilation. As against this, we have the imperative necessity for a light and compact machine occupying a minimum space, and which can be placed below the floor of the car in the most inaccessible position.

Reliability of service usually implies constant care and watching, a condition absolutely at variance with those obtaining in railway operation. Reliability of service makes a slow-speed motor desirable, but slow-speed motors are heavy.

Ample radiating surface must be provided, and yet the motor must be compact. It must be open to the air for ventilation, and yet tight to water and dust. It must be very rigid to stand up against the constant jarring and vibration, and yet must be so constructed as to be easily dismantled for repairs. It must be ready at all times to carry two or three times its rated output and yet must operate normally with a respectable efficiency.

When one considers the number of motors in use and the rarity of breakdowns, it is apparent how well all of these conflicting demands have been met. And last but not least, a motor is turned out which is an almost perfect commercial article. Here, indeed, is a triumph of design which excites our admiration!

ATTENUATION AND DISTORTION ON LONG-DISTANCE TELEPHONE AND POWER TRANSMISSION LINES REGARDED AS HYDRODYNAMIC PHENOMENA.

BY HENRY T. EDDY.

The analogy between a steady flow of water in a long pipe under the action of a constant head and a continuous current of electricity under some constant pressure, such as is furnished by one or more cells of a battery, has often been employed to give a clear elementary physical conception of the mathematical relations expressed by Ohm's law. In this case the applied pressure is gradually consumed by the resistance experienced by the current and in strict analogy with the flow of water, the loss per unit of length is proportional to the product of the square of the current and the first power of the resistance. So far as the mathematical relations are concerned the two problems are identical.

It is the object of this paper to extend this hydrodynamic analogy to the more complicated case of long-distance electric transmission by alternating currents in general.

Telephone transmission has been specifically mentioned in the title in order to include the general case of variable frequency. The importance of thus extending and enlarging this analogy will be evident when we reflect that all the complicated phenomena of long-distance electrical power transmission by any combination of land lines and cables, with their sending and receiving apparatus, may be completely reproduced in all its details of operation by simple pumping machinery, with its transmission pipes and air chambers, whose manner of operation may be made clear to any one without the aid of higher analysis.

Let us first take the case of a double-acting pump cylinder and piston in which the two ends of the cylinder are connected by a simple pipe or by-pass without valves. When this apparatus is filled with water and the piston is moved back and forth by a uniformly rotating crank the water is forced through the by-pass alternately from one end of the cylinder to the other. If the by-pass is short the resistance to motion may be taken as due to fluid friction only, since the inertia of the water may then be disregarded.

This is in every particular analogous in the manner of its operation to a sinusoidal electro-motive force acting in a circuit whose induction and capacity may be disregarded in comparison with its ohmic resistance. But in case the pipe connecting the ends of the pump cylinder be made very long and the size sufficient to greatly reduce the friction, we may disregard this in comparison with the resistance due to the inertia of the water. The resistance due to inertia is proportional to the product of the mass of the water moved by its acceleration. Since this acceleration is greatest at the beginning of the stroke, and vanishes at middle of the stroke, where it changes to a retardation of amount increasing to the end of the stroke, it is evident that the phase of the current lags a quarter of a revolution or period behind that of the pressure; the pressure being a maximum at the beginning of the stroke, and the current a maximum at the middle of the stroke. During the retardation of the piston the inertia of the water acts to drive the piston forward, and (disregarding friction) as much energy is returned to the piston during retardation as is exerted by it during acceleration, so that, on the whole, no loss of energy occurs during the stroke. In these particulars this case differs from that previously considered, where the pressure is in phase with the current and energy is expended against resistance during the entire stroke.

Now, suppose that fluid friction and inertia coexist in the connecting pipe. It is evident that their coexistence does not affect the separate actions which have been described. The current or flow back and forth is that due to the reciprocating motion of the piston, and the pressure is the resultant of the two pressures already described, differing in phase by quarter of a period. The lag of the current will, therefore, be less than a quarter of a period.

The inertia of the water is entirely analogous to the self-induction of an electric circuit, and the care of combined fluid friction and inertia is mathematically in every particular the same as an alternating-current circuit having distributed ohmic resistance and self-induction.

Next let us imagine the short by-pass first considered to be sufficiently increased in diameter to make it a globular chamber as large or larger than the cylinder itself, and let it be furnished with an elastic diametrical diaphragm (of sheet rubber, for example), which occupies a diametrical position whenever the piston is at the middle of the stroke. It is evident that when the piston is at the beginning of the stroke, the tension of the stretched diaphragm exerts a negative pressure or suction to force the piston forward in its stroke, which vanishes at the middle of the stroke, after which the pressure exerts a retardation whose amount increases to a maximum at the end of the stroke. But the total energy exerted by the diaphragm and restored to it is equal.

The action of the diaphragm differs from the action of the inertia of the water previously considered in this one particular only: it exerts its greatest forward pressure at the instant the inertia exerts its greatest back pressure, consequently, when we disregard fluid friction the phase of the current is one quarter of a period in advance of the pressure.

It thus appears that the effect of such a diaphragm is opposite to that of the inertia of the water, so that a diaphragm having sufficient tension would completely destroy the effect of the inertia of the water.

Furthermore, it may be noticed that a somewhat different device from that just mentioned might be employed, whose resultant action would nevertheless be of the same nature. For example, instead of enlarging the by-pass, let two equal air chambers be placed on it, one near each end of the cylinder.

The general effect of this arrangement is to relieve to a greater or less extent the great pressures, positive or negative, at each end of the stroke arising from the inertia of the water.

This is in fact the manner in which relief is actually obtained in pumping machinery from the shock and greatly increased pressure at the beginning and end of the stroke arising from the inertia of the water.

Mathematically the effect is the same as that of the diaphragm previously described.

The operation of the diaphragm and air chambers just considered is strictly analogous to that of capacity in an alternating-current circuit, the diaphragm to capacity in series, and the two air chambers to capacity in shunt, and by these self-inductions may be neutralized to a greater or less extent according to their relative amounts.

We have thus far considered merely the peculiarities of the transmitting or connecting pipes in their relation to the double-acting force pump, regarded as the source of energy. We need next to consider a receiving pump which shall take and utilize the energy not expended in fluid friction. Let the receiving pump be assumed at first to be exactly like the force pump, and to actuate a crank, flywheel and other machinery on which

energy is expended uniformly. The crank end of this second cylinder is connected directly by a pipe with the crank end of the force pump and the other ends likewise. In case the energy expended in fluid friction and inertia may be neglected in comparison with the energy transmitted, this arrangement will transmit power from the driving crank to the driven crank much as would a belt or train of cog-wheels. But suppose now that the second cylinder is connected to the first by very long pipes, miles long, for example, in which the inertia of the water becomes a controlling factor of the transmission. It would evidently become practically impossible to make the water oscillate with any rapidity in such a closed pipe under ordinary circumstances. But let there be a series of air chambers, uniformly distributed, along the entire length of the connecting pipes, or what would amount to nearly the same thing, let the pipe be an elastic hose requiring equal pressures to enlarge or diminish its cross-section.

This will at once entirely change the circumstances of the case, for the air chambers near the force pump will readily receive the water as it flows from the force pump, and transmit it to those next along the line, and so on, so that a wave of pressure will pass along the pipe, and at the same velocity a wave of current will pass, having its maximum flow at points where certain high-pressure air chambers are discharging into those next along the line. By these progressive pressure and current waves energy will be transmitted to the working cylinders, which need not in this case be of the same cubic capacity as the force pump. Several complete waves may be in progress of transmission along the pipe at once. The frequency of oscillation in the working cylinder will be equal to that of the force pump to an amount which may be computed in any given case.

But it will lag in phase behind that of the force pump to an amount due to the number of waves and fractions thereof in progress of transmission along the line, and to the inertia of the working piston, etc.

It is evident that when the two cylinders are equal in every respect, except that the piston of the second cylinder is of such large mass that its inertia is great, and when, in addition, we may disregard fluid friction, and the flywheel of the second cylinder is running idle, that no work is expended in the system. In this case the second piston will originate transmission waves precisely as does the first, but in opposite direction. The resultant of these equal and opposite progressive waves will be a system of stationary waves along the line. Whenever the amount of energy used at the working cylinder is small compared with the total energy, kinetic and potential, at and near the receiving apparatus, the waves originating there will approach the magnitude of those received by it. Any discontinuity of mass in the current flowing in the pipe, as, for example, mercury in place of water for some part of the length of pipe, will originate reflected or return waves. To ensure good transmission little or no discontinuity in the distribution of the inertia along the pipe should occur at any point of it, such as would be due to changes of size or otherwise.

All these results are equally true of alternating-current circuits.

It may be shown from elementary considerations that the progressive velocity of the waves in the transmission pipe under consideration is constant for all frequencies of oscillation in case of a pipe in which the friction may be disregarded, but that the velocity increases as the square root of the frequency in any case where the inertia of the current may be disregarded.

The case of the unequal velocity of the waves propagating the harmonic components of sounds in telephone transmission by reason of their difference of pitch, which is one cause of the distortion of sound in long-distance telephone transmission, has been treated at length in the researches of Dr. Pupin, who has investigated very fully the amount and distribution of the inductive (or inertia) loading necessary in order to render lines practically distortionless. It is equally a hydrodynamic phenomenon. The one question remaining for elucidation is that of the attenuation or gradual diminution of amplitude of waves as they progress along the line.

It may be readily shown that in both of the two extreme cases already considered, *viz.*, those in which either friction or inertia is disregarded, that the logarithm of the reciprocal of the amplitude or intensity of the wave at any point varies directly as the product of the distance of the point from the source of the wave by its velocity. Since this velocity has already been shown to be constant in case the fluid friction may be disregarded and to increase with the frequency in case inertia is disregarded, it is evident that attenuation depends upon frequency in case of fluid friction without inertia, but is independent of frequency in case of inertia without fluid friction. Such unequal attenuation in the telephone obliterates to a greater or less extent tones of high pitch before it does those of lower pitch. It is therefore necessary to distinct transmission that the self-induction of the line should be large enough to store a large amount of kinetic and potential energy in the wave motion along the line, which in all its aspects is strictly analogous to the wave motion propagated in the water in the apparatus just described.

The National Electric Light Association.

The following is an extract from a letter from Mr. Charles E. Scott, treasurer of the Bristol (Pa.) Electric Light and Power Company, to the secretary of the National Electric Light Association. This has been printed and sent to small stations throughout the country:

"I have your kind favor of the fifth instant, regarding the convention of the association, and am very sorry I could not get to Cincinnati.

"Although ours is such a small company, I feel that much of our success is due to personal contact with the officials of other companies and with the supply men whom we meet at the convention. In fact, I know that in the matter of prices we have done better because of our attending conventions and getting acquainted with the sellers of goods. We get rates on small lots that the big companies have hard work to get, and we get information on lots of subjects that is of vital importance in running a small country plant. I think the association is really of more use to such a plant as ours than to the big fellows. The rubbing together; the comparing of notes; the broader, better views obtained—all tend to the improvement of the small company, and make life easier for the official who is fortunate enough to meet men who know vastly more than he does, and who—in my experience—are as ready to impart information as to ask for it.

"We get along by declaring an eight-per-cent dividend and laying by about two per cent per annum besides; but if we had remained shut up in our shell at Bristol, I doubt if we could have made half of it.

"Very sincerely yours,

"CHARLES E. SCOTT."

June 6, 1902.

The following new members have been recently added to the list:

Adrian, Mich., Electric Light and Power Company.

Corsicana, Tex., Corsicana Gas and Electric Company.

Corunna, Mich., Shiawassee Light and Power Company.

Fond du Lac, Wis., Fond du Lac Street Railway and Light Company.

Franklin, Pa., Franklin Electric Company.

Joplin, Mo., Southwest Missouri Light Company.

Kokomo, Ind., The Kokomo Railway and Light Company.

Madisonville, Ky., Bailey Light and Water Company.

Oconto, Wis., W. A. Holt.

Ottumwa, Iowa, Ottumwa Traction and Light Company.

Provo, Utah, The Telluride Power Company.

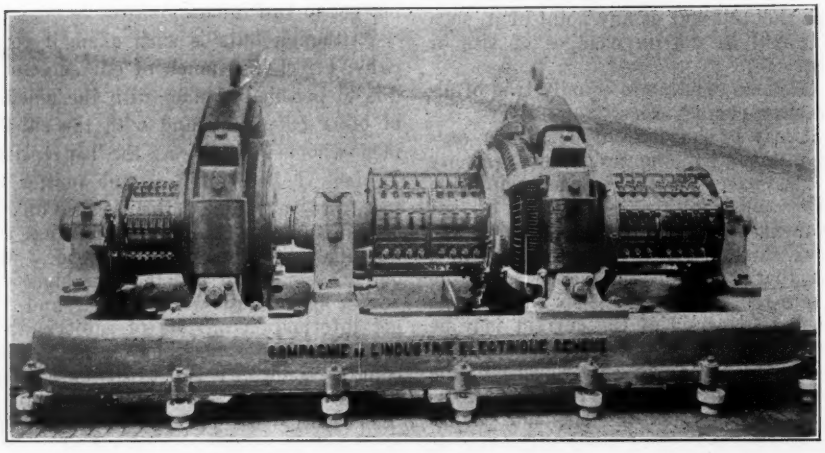
Southbridge, Mass., Andrew F. Hall.

Transmission of Energy from St. Maurice to Lausanne, Switzerland—II.

Employing the Series System at Twenty-three Thousand Volts.

By Enrico Bignami.

THERE are four series motors each driving a three-phase alternator. giving 3,000 volts for distributing power and light at Lausanne and in the suburbs. Two of these alternators may also be driven directly by a steam engine. It may be noticed that the motors, although placed on a high-tension circuit, are actually exposed to a lower voltage than the secondary generators.

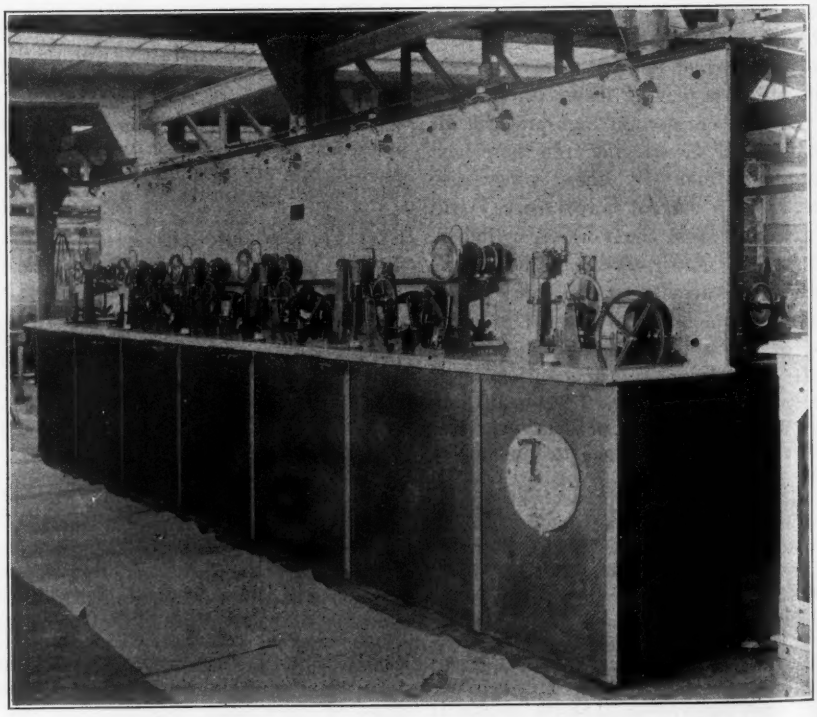


BOOSTING SET FOR 200 KILOWATTS, 4,000 AMPERES, INSTALLED FOR THE EDISON ITALIAN GENERAL ELECTRIC COMPANY AT MILAN.

The fifth motor drives a Thury constant-current generator of 400 horsepower, furnishing current for the railways. The installation is completed by a secondary reserve generator giving 600 volts for the railway, and a battery of accumulators with an automatic Thury booster.

The purpose of the booster is to permit charging and complete discharging of the accumulators, while maintaining automatically a perfectly constant pressure on the distributing network. It also enables the end-cells to be done away with and thus effects an important economy in installation and maintenance. The armature of the boosting dynamo is thrown in series on the battery circuit, and is designed in view of the overload which they must furnish. The exciting current, in shunt, is automatically controlled by a Thury regulator in such a way as to increase by the necessary amount the tension of the network or of the accumulators, in order to charge or discharge them.

The action of the booster is as follows: At charge the booster furnishes the increase in pressure necessary to the network to bring the pressure to 2.6 or 2.7 volts per element. At discharge they raise the voltage at the batteries so that the pressure is maintained rigorously constant and equal to that of the network. The change from charge to discharge and the reverse takes place automatically without necessitating any manipulation whatever. The variations in voltage are corrected without delay, independently of the output or the degree of charge or discharge of the batteries. This is obtained in a very simple manner by the application of the Thury regulator which acts through the excitation of the boosting dynamo.



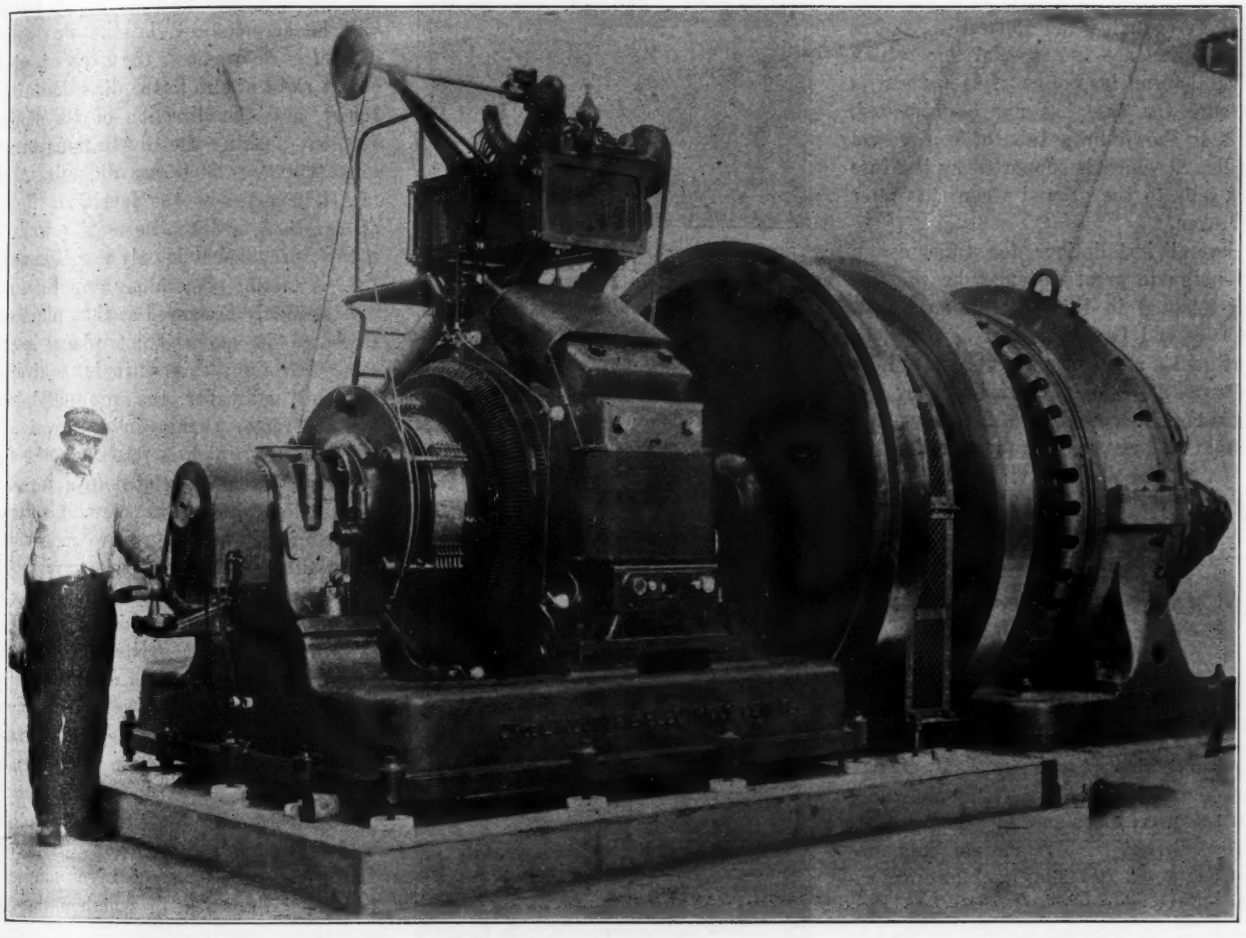
AUTOMATIC CONTROLLING SWITCHBOARD FOR THE BOOSTING SET AT THE STATION OF THE EDISON ITALIAN GENERAL ELECTRIC COMPANY AT MILAN.

The regulator itself is driven by a small motor. Its action is entirely mechanical, that is to say, no contact relays are used; the solenoid acts directly and without effort upon a pawl and ratchet system.

The sensitiveness of the regulator can be anything desired. Ordinarily the limit is one per cent, or one-half per cent above or below normal. The boosters are ordinarily driven by electrical motors operated from the network. They can, however, be driven in any other manner. This principle of the booster can be applied successfully to lighting batteries, even for small installations. To do this economically, the booster should be driven by a motor op-

erated from the general system. A special type of dynamo has been made for this important work, carrying on a single shaft two armatures, one of which feeds the network, while the other serves for charging the batteries.

These automatic booster regulators have been applied with much success by the Compagnie Industrie Electrique, of Geneva, both for lighting stations and traction. One of the most interesting and complete of these systems has been realized by the above company for the



ONE OF THE RECEIVING MOTOR-GENERATOR SETS AT LAUSANNE, SHOWING A 500-HORSE-POWER CONTINUOUS-CURRENT MOTOR DRIVING A 3,000-VOLT THREE-PHASE ALTERNATOR.

Societe Generale Italienne Edison, at Milan, Italy.

The transmission line is protected by a large number of lightning arresters with arms, and by other arresters of a new type called "C. I. E.," and made by the Compagnie Industrie Electrique. These apparatus have the great advantage of discharging continually the line without drawing an arc.

The question of lightning arresters for the protection of electric machines becomes more and more important every day at the same rate at which industrial voltages increase and distributing networks grow in output and length. Lightning is so capricious in its effects that it is unfortunately impossible to guarantee in all cases the efficacy of lightning arresters. Still, one realizes the great progress of the last few years, and can say at present that accidents to machines from lightning are the exception.

Most arresters at present in use have a great disadvantage in that they draw an arc, and as a consequence short-circuit the machine and ground it. Now, the arresters of the Compagnie Industrie Electrique have a great advantage in that they can be placed not only between the conductors and the earth, but in certain cases between the terminals of the motor, preventing wandering currents and electric charges from occasioning disturbances in the machines or in the electric installations, and protecting from static discharges due to belts or other causes. The apparatus is shown ready for use in the illustration, where it is apparent with what ease the tubes can be removed for charging.

At the instant of a lightning discharge they offer an impassable resistance to the current from the installation, but allow a high-potential current, due to atmospheric discharges, to pass easily. They are always ready to work, and, except in the case of exceptional discharges, their life is indefinite. For these exceptional cases a fuse is placed in series with the arrester tube, and this melts in case of accident, thus automatically cutting the apparatus out of the circuit. On the other hand, as they offer a path to the earth, they are useful, not only in discharging atmospheric or static effects as ordinary lightning arresters, but withdraw continually electrical charges occurring in the neighborhood of the lines, and permit these currents to glide easily into the earth. The expense which they cause is largely compensated for by the protection given to the machines, for the rewinding of an armature burned by lightning is always costly and generally causes considerable disturbance to the service.

We can briefly resume the principal advantages of this new type of arrester, the "C. I. E."

First—They occasion no short-circuit

to the machines from an atmospheric discharge.

Second—They continually discharge the lines to be protected.

Third—They require but small space, as the complete apparatus occupies a cube thirty centimetres on the side.

Fourth—By virtue of the contact jaws the arrester and fuse can be replaced rapidly in case of accident, even during operation.

Fifth—The arrester, being completely enclosed, is not affected by moisture and can be mounted outside.

Sixth—Finally, the apparatus requires no maintenance nor special supervision other than an inspection after a storm to be sure the fuse has not been melted. This is shown by a tube of compressed cardboard which is supported by the fuse and falls to the ground when the latter is broken.

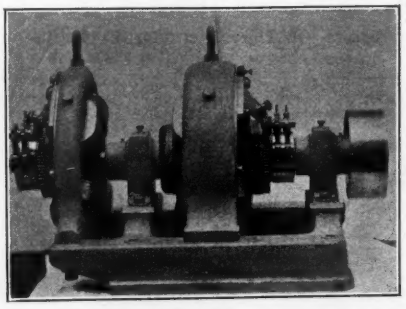
Several installations for transmission of energy to great distances by the system adopted in this installation of St. Maurice and Lausanne, that is to say, by continuous constant currents at a high pressure, have been carried out by the Compagnie Genevoise. The most important of these may be mentioned—that of La Chaud de Fond, that of Locle in Switzerland, and that of Ikewar in Hungary. Of these I will have more to say later.

THE MAGNETIC FIELD OF A MOVING ELECTRON.

BY J. A. FLEMING, D.SC., F.R.S.

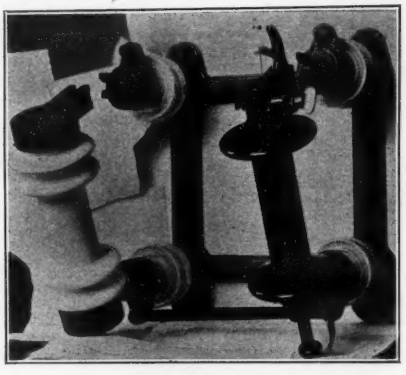
The production of a magnetic field of force by a moving electron has been treated mathematically by J. J. Thomson, O. Heaviside, J. Larmor, and other mathematicians. The fact that a statically charged body in motion does produce a magnetic field was first experimentally demonstrated by the late Professor H. A. Rowland in 1875 in the laboratory of Von Helmholtz in Berlin. In spite of a negative result by Crémieu, the fact was again verified by Rowland shortly before his death, and has been confirmed by recent experiments by Professor Trowbridge. If any one is desirous of gaining a general notion how this magnetic effect is produced without the aid of mathematical symbols, the following considerations may be of assistance. Let us imagine an electron as a small sphere, negatively charged, existing in space at a distance from all other bodies and at rest. Then it creates around it electric force radially in every direction. The precise physical nature of this effect in the surrounding ether we do not know, but it is, mathematically speaking, a vector.

Suppose, then, the electron moves forward in a straight line. For the sake of avoiding complexities let us consider only the electric force along a line drawn through the electron at right angles to the direction of its motion. As the electron moves forward it carries this system of electric force with it. Hence, along the



THURY'S AUTOMATIC BOOSTING SET.

line considered the electric force is, so to speak, being transferred parallel to itself—that is to say, it is continually ceasing to be along a certain line and being recreated along another line parallel to it. It is clear that if we have a force of any kind, F, acting at any point and we apply to it a couple or torque, each force of which is also equal to F, in such a manner that the original force



THE "C. I. E." LIGHTNING ARRESTER, SHOWING THE EASE WITH WHICH RENEWALS MAY BE MADE.

opposes one of the constituents of the couple, then the combination of the force and the couple is equivalent to a shift of the original force parallel to itself through a distance equal to the arm of the couple. Without elaborating this any further any one will see on reflection that if a force is continually shifted sideways, remaining always parallel to itself, it is equivalent to the continual creation of a couple or torque which accompanies the shifting force. Conversely, if a torque or twist acts on a body and its point of application is continually being shifted so that the twist axis remains parallel to itself, it is not difficult to see that this shifting or sideways motion of the twist is equivalent to a continual creation of a linear force which accompanies the moving twist. The meaning of this may perhaps be most easily seen by considering a squirt of water, such as that given out by a fire-engine hose, taking place in water. If the squirt of water is moved sideways through the water, moving in a direction at right angles to the direction of the squirt, this motion will be accompanied by the production of whirls or vortices, the axes of which are at right angles to the direction of the squirt, and the direction of its motion. Without pushing the illustrations to any greater extent, it is not difficult to obtain a glimpse of the fact that if any change in a medium, no matter what its nature, provided it is only a vector quantity, is taking place along any line, and it is suddenly destroyed at that place and recreated in an adjacent place in the same direction, this shift is equivalent to, and calls for the production of, another vector change in a direction at right angles, which is related to the first just as a torque is related to a force, or a whirl to a squirt, or a screw to a thrust. Accordingly, the progressive movement of an electron through space, carrying its system of electric force with it, causes the production of another effect which by symmetry must exist along circular lines embracing the path of the electron. This is the magnetic force. Our knowledge of the nature of the ether change which constitutes electric displacement or electric force is not sufficient to enable us to say whether the electric force is to be looked upon as analogous to a force and the magnetic effect to a couple or twist, or *vice versa,* or whether they are something totally different. The magnetic optic phenomena give support to the view that all along lines of magnetic force there is something of the nature of rotation going on. On the other hand, some other explanations are more easy if we assume that it is the electric force which is the whirl and the magnetic force which is the squirt. What is clear from the Rowland discovery of the magnetic effect of a moving static charge and the Faraday discovery of the electromotive effect of changing magnetic force is that a stated charge moving through the ether has an effect which is analogous to moving a squirt of water through water sideways, and this is known to produce water vortices, the direction of

whose axes are at right angles to the direction of the squirt and its lateral movement. Quite similarly the effect of moving a line of electric force sideways is to produce a line of magnetic force in a direction at right angles to the direction of the electric force and its lateral movement. All this and more is, of course, embodied in the mathematical expressions, but it is useful sometimes to endeavor to visualize even faintly the physical actions occurring without employing algebraical symbols.

One possible, though perhaps imperfect, hydrodynamic analogue of an electron would be a hollow ball pierced with numerous small holes from which squirts forth a fluid stored up under pressure in its interior. Such a ball, if immersed in stationary fluid, would, if at rest, merely produce radial squirts of fluid. If, however, it was moved about it would create also endless or ring-shaped vortices as well, which would embrace the line of its motion, and would correspond to the magnetic lines of force of a moving electron. These illustrations may not be perfect, but they may serve the purpose of throwing a glimmer of non-mathematical light upon the subject.

It may, in conclusion, be pointed out that the addition to its apparent or stationary mass which a moving electron experiences is due to the fact that there is energy stored up in the surrounding medium in connection with the magnetic field produced by its movement. Hence work has to be done on an electron to accelerate it over and above that required to generate increase of kinetic energy involved in its motion simply as a piece of matter.—*Electrical Times* (London), July 17.

PACIFIC COAST ELECTRIC NOTES.

NEWS OF ELECTRICAL PROGRESS AND INDUSTRY IN THE FAR WEST.

The annual stockholders' meeting of the Bay Counties Power Company was held on July 22 at 324 Pine street, San Francisco. The annual report of the president for the year ending May 31, 1902, was submitted. From this report the following abstract is taken: On the Nevada division a substation has been completed on the property of the Nevada County Traction Company, and sixty-cycle transformers have been installed, which will supply a suitable current for the electric cars. Electric power for mining companies will be furnished later from this station. The equipment of the Colgate power-house has been practically completed. There are now installed and in operation in this power station generators aggregating 9,420 kilowatts, and water-wheels for their operation. An additional thirty-inch steel pressure pipe will soon be completed. A seventy-five-foot dam is practically completed at the Lake Frances storage reservoir available for Colgate. The Yuba power-house has been operated under an almost constant full load, but the expense of maintenance and of operation has been merely nominal. Some slight changes in the water-wheels will be made by the manufacturers to make them still more efficient. At Oroville several additional power lines have been extended to new gold dredgers, and several more dredgers will be supplied when they are completed. The voltage has been raised from 2,000 to 4,000 volts on the greater portion of the secondary distributing system, enabling more power to be supplied without additional wire. A small substation has been installed at Bear River, with transformers to supply electricity for the new gold dredgers that will operate in that river.

On the Bay division the lines have been extended considerably. A line one and one-half miles in length has been built to connect with the Pacific Portland Cement Company's substation near Suisun. Also a twelve-mile line from Crockett to Bay Point, to supply the smelter of the Pacific Reduction Works. Both of these companies have closed long-term contracts for a large amount of power for twenty-four hours per day. Transformers have been installed at Dixon, and several have been ordered for Suisun, where they will be installed in the substation of the local companies. Light and power will be supplied for the two towns. A new power line, four miles in length, will soon be completed to supply Vacaville with light and power. Another line will be extended to Napa Junction to supply power for the large cement works of the Standard Portland Cement Company. Electric motors, having a total capacity of 1,800 horse-power, have been installed to utilize the electricity which will be furnished under a long-term contract. Some small lines have been built to the grain warehouses in Port Costa. The contract for light and power for the Mare Island Navy Yard will be operative in about four months. Contracts executed for connection within the next six months will give net earnings of over $414,000 per month.

The Home Telephone Company, of Los Angeles, which is installing a Kellogg system, is having some large orders for underground cables filled by the Standard Underground Cable Company. The cables are of various sizes. The lead covering of the cables is put on at the Standard Underground Cable Company's plant in Oakland, Cal.

The Commercial Pacific Cable Company has purchased land at Waikiki Beach, near Honolulu, for a cable landing. The site for the landing-house is being cleared, and the new cable station will be ready in ample time for the opening of business next November. It is expected to have the submarine cable laid between San Francisco and Honolulu by next Thanksgiving Day. It will take some time to install the land cable from the landing to Honolulu. A quantity of three-inch pipe has been ordered; this will be placed underground and used for ducts. Inside of these conduits will be placed three standard underground lead-covered cables, each containing four conductors.

It is authoritatively stated that the Bay Bend Tunnel water system has been sold by Major Frank McLaughlin to the Los Angeles capitalists who organized the Western Power Company. This company, headed by E. J. Earl, of Los Angeles, recently acquired reservoir sites and water rights in Plumas County, which would enable it to develop a large amount of electric power. The distance of transmission from Plumas County to San Francisco Bay would, however, make the pole line very expensive. From the Bay Bend Tunnel the distance to San Francisco is considerably shorter, being only about 200 miles. It is estimated that it would cost about $2,000,000 to install a plant at that point which would transmit 25,000 horse-power to San Francisco. While the Bay Bend Tunnel, which cost $500,000, will save a good deal of hydraulic work, it will yet be necessary to expend $300,000 on additional hydraulic work and water-wheels.

M. Adrian King recently appeared before the San Francisco board of supervisors to urge that action be taken on his application for a franchise for an independent telephone system. He has offered to bid $50,000 for the franchise when it is put up at auction. Certain supervisors were doubtful as to his financial standing, considering him in the light of a promoter, and action was deferred for three weeks. It was pointed out that King had sold the franchise which he obtained in Los Angeles to the Home Telephone Company. However, it is known that King has successfuly financed telephone companies in the East, and he may be able to start a successful opposition company in San Francisco.

J. R. Harvey, who purchased the municipal electric light system in Vancouver, is preparing to install a new electric light and power plant which will cost $450,000. His franchise runs for twenty-five years. A contract has been closed with the Stanley Electric Manufacturing Company for the electrical machinery.

THE CONSTRUCTION OF TELEPHONE EXCHANGES—XXXV.

BY A. E. DOBBS.

LOCATING LINE TROUBLE BY TESTING.

The writer, as well as many manufacturers of testing sets, has frequently been asked to formulate rules for the locating of crossed and grounded lines from the central office, in order that the manager, before ordering a repair man out on trouble, could inform him as to its probable distance from the office and preparations made for a short or long trip, as the wire chief might indicate.

Many telephone managers having observed the ease with which telegraph wire chiefs locate crosses and grounds on lines under their care imagine that the same methods of measurement could easily be applied to their own circuits.

Well, so they can, to single lines with but one telephone connected, provided the line has been previously measured and the manager is familiar with the process of calculating divided circuits, but with not the same degree of certainty to toll or party lines with several stations bridged on, because, the bells being in multiple across the lines, complicated calculations are necessary and correct deductions difficult to arrive at.

A telegraph line is a very simple circuit, being a single wire of large size and uniform conductivity, grounded only at the ends, with all relays looped into and forming part of the single wire.

In order to find the distance to a fault, as a broken, grounded line or two crossed wires, it is only necessary to measure the number of ohms resistance with a bridge, divide by the number of ohms per mile of wire, and deduct the resistance of the instruments in the section under test, which has been previously ascertained.

As a rule among telegraph men, every mile of the line has been carefully measured beforehand with standard, accurate instruments, and its resistance from station to station tabulated for future reference.

Moreover, the line is under the constant care of operators, who can hear what is going on over the wire, and will soon detect trouble if there is anything wrong, besides knowing enough to assist the general manager or wire chief by opening their keys or plugging on ground wires until the trouble is located between two offices. The chief, then, makes his galvanometer or bridge tests, in order to ascertain the probable distance of the trouble beyond the last "clear" office. Should there occur a cross between two lines it is an easy matter to loop them together into the X-terminals of the bridge, measure the resistance of the loop thus formed, and estimate the distance by the number of ohms per mile of both wires, and, as already stated, subtracting the resistance of the relays in circuit, the only possible source of error being the resistance of the ground contact itself, or, as in the case of a cross with a foreign wire, the possible length and resistance of the latter before it connects to earth.

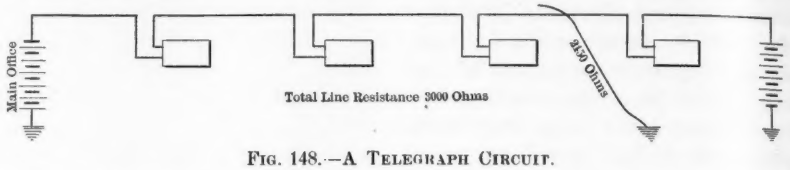


FIG. 148.—A TELEGRAPH CIRCUIT.

In Fig. 148 we have a telegraph line of, say, 100 miles length, into which is looped four relays having a fairly uniform resistance of 250 ohms each, or 1,000 ohms for the four.

Supposing that the wire will measure twenty ohms to the mile, this would give us 2,000 ohms of wire resistance, which, with that of the relays, makes a total of 3,000 ohms. A ground trouble occurs on the line, and the wire chief finds that offices 1, 2 and 3 can be called, while No. 4 can not. The trouble, therefore, must lie between Nos. 3 and 4. As the two offices might be thirty miles apart, he would like to know how to reach the trouble in the shortest space of time and with the least expenditure for labor, and, especially if it should be a railroad line, to tell the repairman what way station to get off at.

Upon measuring the line he gets a deflection indicating 2,450 ohms from the office (left-hand side of the figure); deducting the relay resistance of 750 ohms, leaves 1,700 ohms of line resistance, and $1{,}700 \div 20 = 85$ miles as the distance to the scene of the trouble. The resistance of the ground contact might be twenty or thirty ohms, but the lineman would be directed to get off the train at the nearest point to the eighty-five-mile mark and look for his trouble, or at least make a test there by cutting in an extra test relay, or, as the distance is only fifteen miles from the distant end, that office might be called over another wire and directed to clear the trouble.

With a telephone toll, or party, line, such as already described, we have a line normally open except for leaks of high resistance bridged across it by the bells, which introduces complex and somewhat vexatious problems connected with divided circuits. Nor are the leakages uniform as the stations are not of a uniform distance apart, and the probabilities are that no two of the bells will have the same resistance. The wire is also smaller and unless of copper is apt to be of a cheaper grade than telegraph wire, and therefore not of uniform conductivity. Again, operators at country telephone stations, unlike telegraph operators, are not likely to call up the controlling office several times a day unless they have business to transact; nor do they have the opportunity to observe whether a station called is answering or not unless they listen in on the line to private conversations, which they should not do.

Probably the quickest and most reliable method of testing for trouble on such a line is to have test stations located at frequent intervals along the line similar to those shown in a previous chapter.

Then, by instructing persons in charge of such stations to call the controlling office once or twice a day trouble on the line will be immediately noted. These calls can also be used for checking previous business.

By this method if trouble develops on the line the operator can plug in his station bell on the good end, cutting out the defective one till the trouble can be repaired, meanwhile leaving his extension bell on the defective end for possible signals from that direction.

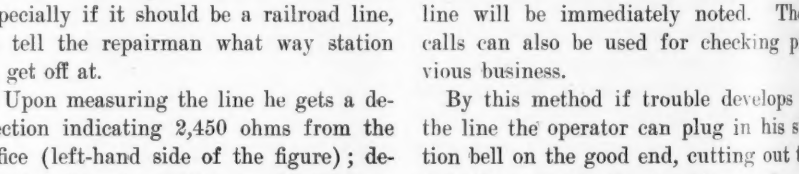


FIG. 149.—A SAMPLE TELEPHONE LINE.

By having the station operators do the calling trouble can soon be located between two stations, and as telephone stations are generally close together, the next best thing is to send a man out to look for it without any further ceremony, as stopping to measure resistance and calculate the result would only be a waste of time.

To illustrate the difficulty of measuring most lines of this kind, let us take

as example a line like that in Fig. 149, which is not an unusual one.

The line is a metallic circuit, of copper wire, No. 12 B. & S. G., having a resistance of 8.5 ohms to the mile (double that, or seventeen ohms per mile for the two wires), twenty-five miles in length and with four stations located at various distances from the central office. If there was only one station on this line and the wires should become crossed, there would be no difficulty in finding the cross, for it could be measured and the distance estimated at the rate of seventeen ohms to the mile, but we have four bells to deal with, each one of which takes its portion of the current and every increase in the number of bells instead of increasing the resistance of the line decreases it.

To illustrate, take four bells, each of exactly 1,000 ohms resistance, group them together, as shown in Fig. 150, and we would find that the resistance has fallen to $\frac{1,000}{4} = 250$ ohms, or, to put it in another way, each bell would take $\frac{1}{1,000}$ of the current, consequently four bells would take $\frac{1}{1.000} \times 4 = 250$. This would be better expressed by reducing these fractions to their reciprocals or rather reducing the resistance of each one to its reciprocal, which is obtained by dividing 1 by the resistance, and in this form 1,000 becomes 0.001. Adding the four together gives 0.004 as the joint conductance of the four bells, and dividing 1 by 0.004 = 250, which brings it back again to terms of resistance. In the example given with Fig. 149, however, no two of these bells are of the same resistance, so that all must be separately reduced to their reciprocals and added together to find their combined conductance, and then reduced back again to find their combined resistance, the resistances of the bells being as follows:

TABLE I.

Station.	Resistance.	Reciprocal.
No. 1.....	1000	.001000
No. 2.....	950	.001053
No. 3.....	1600	.000625
No. 4.....	1200	.000833
Total...	....	.003511

The combined conductance therefore of these four bells being 0.003511, the resistance would be just the reverse or 1 ÷ 0.003511 = 285 ohms, as the resistance of these bells if placed on a short-circuit, as in Fig. 150, and the same method could be applied to any number of bells. The greater the number of bells placed across the circuit the lower the resistance and the greater the sum of the reciprocals or joint conductance.

But in the case of the line given in Fig. 149, we have another factor, the line resistance to be considered. The resistance of the line, only when measured from the office, is as follows:

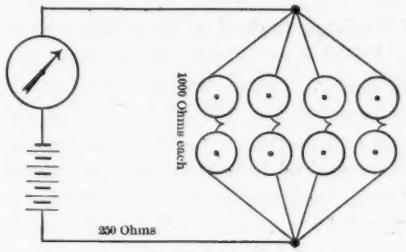


FIG. 150.

TABLE II.

Station.	Miles.	Resistance.	1 Bell Only.*
No. 1.....	5	85 ohms.	1085 ohms.
No. 2.	12	204 "	1154 "
No. 3.....	19	323 "	1923 "
No. 4.	25	425 "	1625 "

But, in the calculations that are to follow, the resistance of the line between

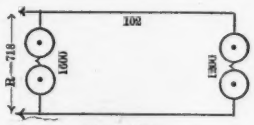


FIG. 151.

stations concerns us chiefly, as these factors and resistance of the bells only will be used and may be stated thus:

TABLE III.

Exchange to No. 1. ... 85 ohms line resistance.
No. 1 to No. 2 .. ..119 " "
No. 2 to No. 3.....119 " "
No. 3 to No. 4 .. ..102 " "

It will now, perhaps, be seen that the resistance and inversely the conductance of each section of the circuit will have to be calculated separately and added together piecemeal, for there is no way by which the resistance of a comparatively long line like this can be averaged.

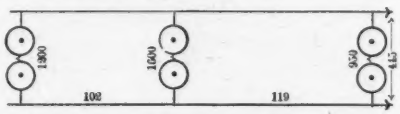


FIG. 152.

To calculate the resistance of the line from the exchange, with all the bells across it, the simplest method is to begin at the outer end or station 4, treating the bell and wire resistance as a loop in the line between stations 3 and 4. The line resistance, as shown in table III, is 102 ohms; the resistance of No. 4 bell, 1,200 ohms, both of which must be added together, inverted, and the inversion of No. 3 bell added to obtain conductance, and then the whole again inverted to obtain the joint resistance of the two bells and line as in Fig. 151.

$\frac{1}{1,200 + 102} + \frac{1}{1,600} = 0.001393 =$ 718 ohms; the resistance of Nos. 3 and 4 joined as in Fig. 151.

We now add the line resistance between Nos. 2 and 3, which table III shows to be 119 ohms, which equals 718 + 119 = 837 which would be the resistance of Nos. 3 and 4 if measured from station 2, with all other bells disconnected.

We now add the conductance of No. 2 bell. $\frac{1}{850} + \frac{1}{950} = 0.002248 = 445$ ohms, the joint resistance of Nos. 2, 3 and 4, Fig. 152.

Now add the line resistance and conductance back to station 1.

$\frac{1}{445 + 119} + \frac{1}{1,000} = 0.002755 = 360$ ohms as the combined resistance of Nos. 1, 2, 3 and 4, to which must be added eighty-five ohms to cover the intervening five miles to the central office, making a total of 445 ohms as the resistance of these bells when measured from central.

After studying the above problem a while it requires no great mathematical ability to discover that, as the bells bring the line resistance down to just about what it would be if there were no bells on, and the line closed at the farther end, a cross in the line anywhere beyond No. 2 would be a difficult thing to locate, except approximately, especially if the cross was caused by a piece of rusty wire thrown on the line by some young American.

Still it is possible to calculate this resistance. With a line cross at No. 2 station, Nos. 2, 3 and 4 would be out of the calculation, and we would have only No. 1 to consider at all.

Following the line distances and resistances given in table II as a matter of comparison, a short-circuit in the line at each of the various stations would read as follows:

TABLE IV.

No. 1..... ..... 85 ohms.
No. 2 ....191 "
No. 3..... .. ..265 "
No. 4..... ....308 "

A study of table IV shows us that at times a testing set would be a very great convenience in estimating the location of crosses, especially if data similar to that already given had been carefully tabulated beforehand when the line was in good condition.

* The fourth column is that of the line with each single bell attached in turn.

The Romanshorn Gas Engine Driven Central Power Station

A Description of a Swiss Installation.

By Frank C. Perkins.

GAS ENGINES are being more extensively used each year in central power stations, not only for extensive manufacturing plants, but also for power transmission plants and for central stations in cities and towns for light and power distribution.

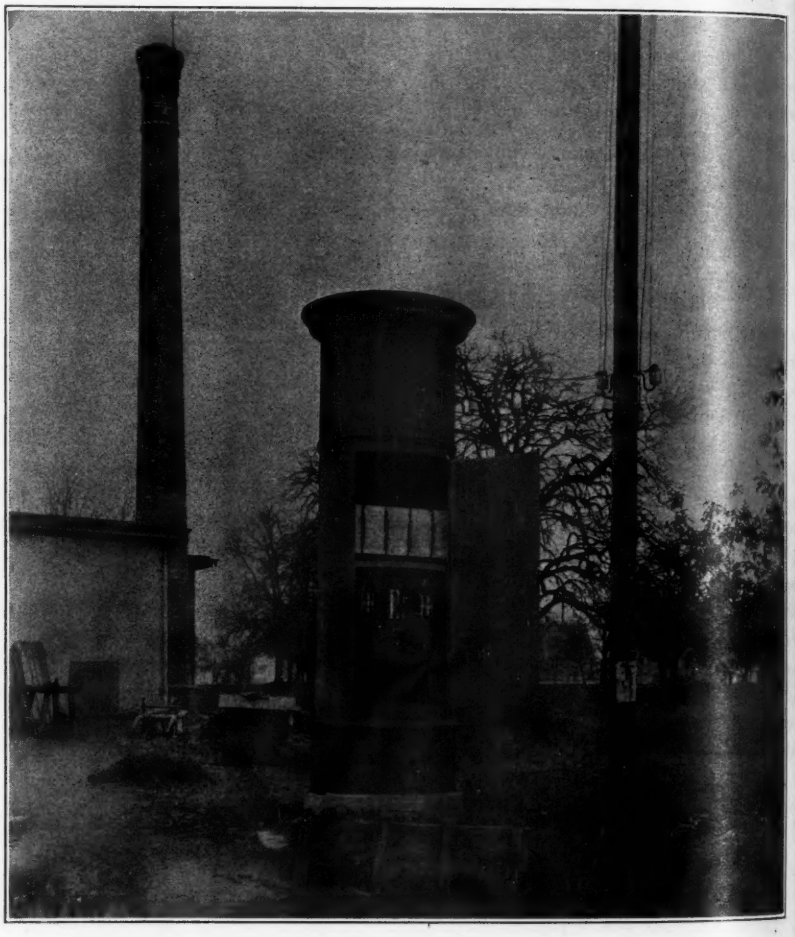
At the Ougree blast furnaces, in Belgium, a number of 600-horse-power gas engines are used in the power station for driving the electric generators, and the waste gases from the furnaces are employed for operating them. The entire plant of the Ougree-Harihaye Blast Furnace Iron Works Company, which is one of the most important in the industrial centre, the basin of the Meuse, between Seraing and Liege, is thus operated by electric power from generators driven by Cockerill high-power gas engines, with the exception of one reversible 10,000-horse-power steam engine which operates one of the large rolling mills.

Among the central power stations operated entirely by the gas engines is that at Romanshorn, Switzerland, which is illustrated by the accompanying photographs. This plant supplies current for a large number of electric motors as well as numerous arc lamps, and about 3,700 incandescent lamps, or about 45,000 candle-power.

The central power station has three main rooms, the largest of which has an area of 4,196 square feet and contains the pumps, gas engines, generators and switchboards, while the other two, of 1,710 and 1,380 square feet, are occupied by the gas plant and workshops. The main engine and generator room is supplied with a traveling crane of 4,400 pounds capacity. The gas plant consists of two generators of the Hirzel type and one generator of 250-horse-power capacity built by the Gasmotorenfabrik Deutz.

On the north side of the engine room there are two Crossley gas engines of sixty and forty horse-power, respectively, driving a countershaft by belt transmission, on one side of which a piston pump is belted and on the other side an electric generator, constructed by the Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland. On the south side of the engine room there are two twin gas engines of the firm Deutz, each of which has a large flywheel in the centre to which is belted a polyphase alternating-current generator. These engines develop 120 horse-power and 140 horse-power at normal and maximum capacity, and operate at a speed of 180 revolutions per minute. An air compressor is installed, which is driven by a two-horse-power gas engine directly coupled, and supplies compressed air at from eight to ten atmospheres to an air-tank of 400 litres capacity. Near the piston pump there is also installed a direct-connected, high-pressure centrifugal pump driven by a Drehstrom motor.

The Oerlikon electrical generator driven by the gas engines on the north side of the engine and generator room has a capacity of sixty-two horse-power and operates at 600 revolutions per minute. It furnishes a three-phase alternating current of a frequency of sixty cycles per second, and has at its terminals a potential of 2,250 volts. The winding on the armature consists of fifteen coils placed in thirty slots, each coil having forty-eight turns of copper wire 2.8 by 3.4 millimetres in section. The exciting coil has 730 turns of copper conductor whose section is 3.8 by 4.2 millimetres. The exciter dynamo is directly coupled to the alternator, the same as the two larger machines.



TRANSFORMER STATION AT ROMANSHORN, SWITZERLAND.

The two large generators at the south side of the engine room also supply a 2,250-volt, three-phase current of the same periodicity, sixty cycles per second. Each armature-winding has eighteen coils of twenty-five turns of copper wire 4.2 by 4.8 millimetres in section. The exciting field coil has 546 turns of 4.5 by 5.1 millimetres in diameter. These machines are

of the inductor type, with both stationary armature and field coils.

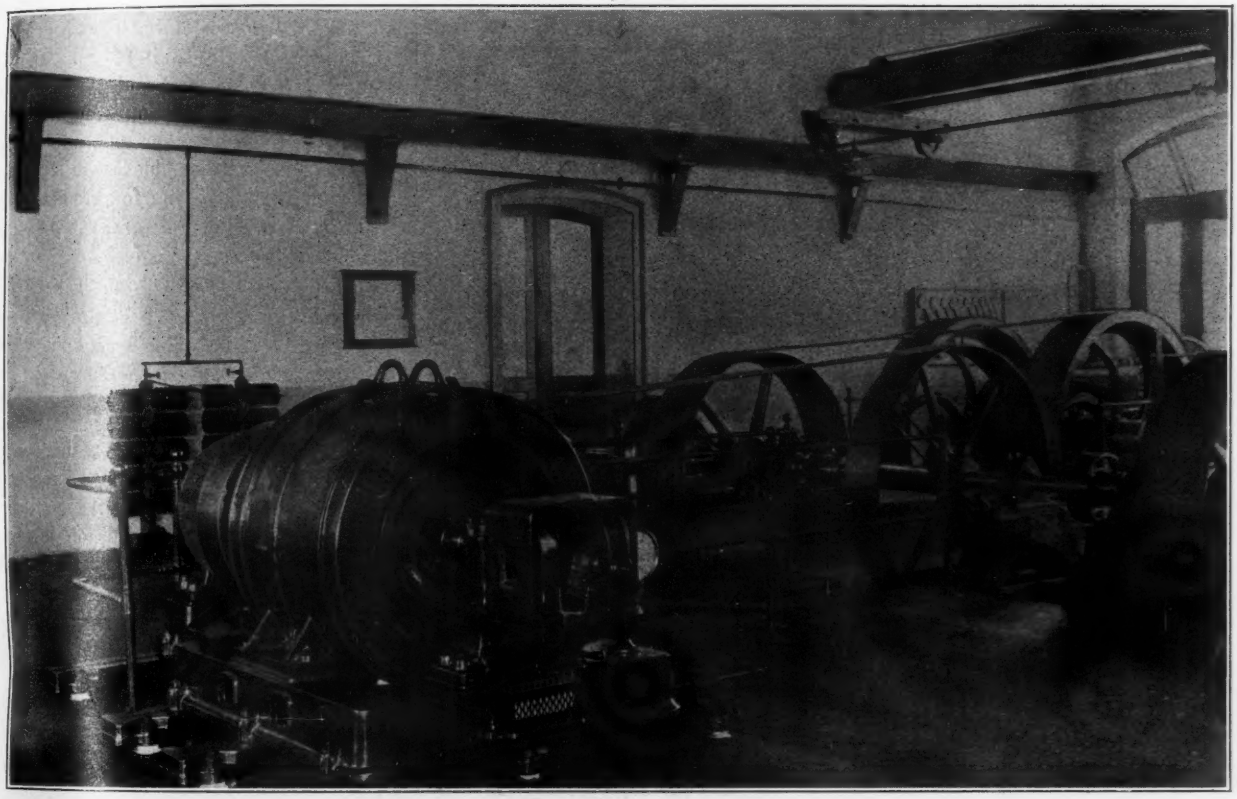
The switchboard is installed for four generators and is made of white marble with iron mountings, and is equipped with main ammeter, voltmeters and switches, as well as the necessary instruments for each generator panel, together with the various main and feeder switches and panel for exciter controlling apparatus.

The primary high-tension line from the power-house to Romanshorn consists of three copper conductors of 5.5 millimetres cross-section, mounted on porcelain insulators and wooden poles. The transmission line to Amrisweil consists of three conductors 8.5 millimetres in diameter, and the number of poles used in the latter line was 340 and in the former 270, while the total length of the transmission line to Romanshorn is 15,400 feet and to Amrisweil 23,600 feet.

At Romanshorn there are eight transformer substations, and at Amrisweil there are four transformer houses, reducing the potential from 2,250 volts to 110 volts and 190 volts for operating motors, lights and motor-generator sets. The secondary distribution at Romanshorn is partly single-phase and partly three-phase, and is 21,300 feet in length, while at Amrisweil the length of the secondary line is 16,700 feet and the three-phase system of wiring is used throughout.

The converter substation is equipped with a twenty-eight-horse-power Oerlikon Drehstrom motor directly coupled to two direct-current dynamos of the same make, of fifteen horse-power, with elastic insulation couplings. There is also a small switchboard with the necessary measuring instruments and controlling switches for both generating and three-phase motor. There is also a twenty-eight-horse-power Drehstrom motor in operation at the power-house, as above mentioned, which drives the high-pressure centrifugal pump at a speed of 980 revolutions per minute, forcing the water under a head of 243 feet. The motors used on the power circuits vary from five horse-power to six horse-power, and are used for driving wood-working machines, machine tools, meat-chopping machines, book-binding machines, shoe-manufacturing apparatus and other industrial purposes in the various factories in these two towns.

The plant is owned and operated by the "Wasser Und Elektricitatswerk Romanshorn," and supplies current for arc lights of 28,000 candle-power and incandescent lamps of 2,400 candle-power. The arc lamps are operated on the direct-current circuits supplied by the two continuous-current machines in the substation which are driven by the Drehstrom motor. The gas engines in this power plant furnish the necessary power for supplying these towns with water, light and motor service.



GAS ENGINES AND GENERATORS IN THE CENTRAL STATION AT ROMANSHORN, SWITZERLAND.

Association of Edison Illuminating Companies.

The eighteenth annual meeting (twenty-third convention) of the Association of Edison Illuminating Companies will be held at the Mount Washington Hotel, White Mountains, N. H., commencing Tuesday, September 9.

A number of valuable papers are in course of preparation on subjects pertaining to the business of the member companies, and already there are indications which point to the coming convention as probably the most valuable of a series of excellent conventions.

The Edison association was organized in 1885 by companies licensed under the Edison patents. It embraces all of the present licensees excepting only a very few.

The Edison conventions are noted for their close application to business, and the higher beneficial results to its members.

The following are officers of the associations: President, Mr. Louis A. Ferguson, Chicago, Ill.; vice-president, Mr. A. W. Field, Columbus, Ohio; treasurer, Mr. Alex. Dow, Detroit, Mich.; secretary, Walter H. Johnson, Philadelphia, Pa.; assistant secretary, Wilson S. Howell, New York, N. Y.

The Power Equipment of the New Iron Elevator of the Iron Elevator and Transfer Company, Buffalo, N. Y.

THE MOST remarkable grain elevator in the world was recently put into service by the Iron Elevator and Transfer Company, of Buffalo, N. Y. This structure, which is shown in the accompanying illustrations, is formed entirely of concrete and steel. It is situated on the Lake Shore & Michigan Southern Railroad, and all grain passing East over this road is weighed and transferred from western into eastern cars at this elevator, which has an actual working capacity of sixty carloads of grain in and out in a ten-hour day. Fig. 1 shows the exterior of the elevator.

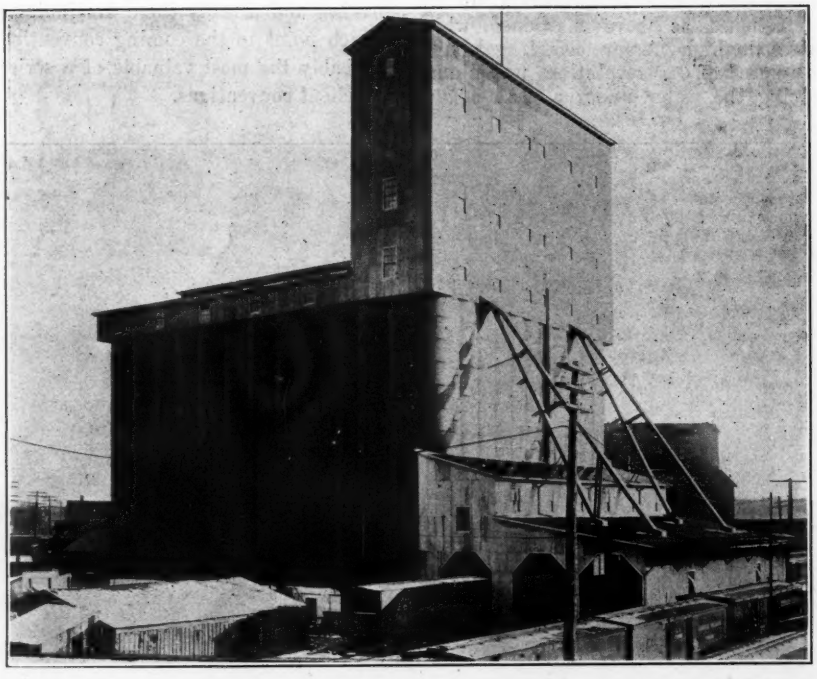


FIG. 1.—EXTERIOR OF THE STEEL AND CONCRETE ELEVATOR OF THE IRON ELEVATOR AND TRANSFER COMPANY, BUFFALO, N. Y.

In addition to the regular work of transferring grain in transit, the elevator is equipped for cleaning and separating the mixed grains and, for this purpose, has a storage capacity of 650,000 bushels. The storage space is divided into ninety separate steel bins with a capacity of from 1,000 to 12,000 bushels each. The bins are of rolled steel plates, cylindrical in shape; they are sixty-five feet deep and the largest ones are fifteen feet in diameter. The foundation is of concrete and is built at a sufficient altitude above the ground to form a working story, or basement, ten feet high, under the bins.

Fig. 2 shows the scale tower. Two seventy-five-horse-power induction motors, three-phase, 480 revolutions per minute, operate four elevating legs, 125 feet (centre to centre) each, with a capacity of raising 6,000 bushels per hour; two belt conveyors, ninety feet (centre to centre) by three feet wide, each with a capacity of 15,000 bushels per hour; one seventy feet (centre to centre) by three feet wide cross-conveyor with capacity of 7,000 bushels per hour; three Fairbanks recording scale pans on the right. Each scale is equipped to weigh 90,000 pounds of grain. A detaining chamber of equal capacity is located directly above each scale. Each detaining chamber may be emptied of full load in fifteen seconds.

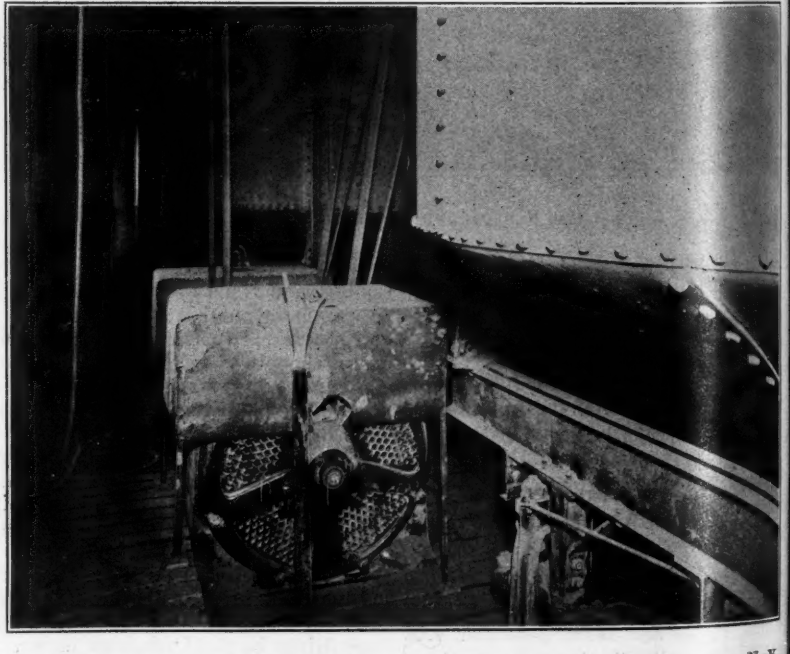


FIG. 2.—THE SCALE TOWER, IRON ELEVATOR AND TRANSFER COMPANY, BUFFALO, N. Y.

Fig. 3 shows the cleaning room. A fifty-horse-power induction motor, three-phase, 480 revolutions per minute, operates two "Invincible" grain cleaners (one of these in foreground); four Shillin & Richards grain shovels; two ninety feet by three feet conveyor belts running in basement, each with a capacity of 15,000 bushels per hour; two twenty-five feet by three feet conveyor belts, each with a capacity of 6,000 bushels per hour running under grain pits below the cars.

The grain is handled throughout the building by means of endless rubber belt conveyors and elevating legs which are driven entirely by induction motors located at various points in the structure. The aggregate power provided amounts to 280 horse-power, which is divided

among five Westinghouse, type "C," induction motors, varying in size from thirty horse-power to seventy-five horse-power each. The power is transmitted from the motors to the machinery by rope drives in every case. Electric power is received from the Niagara Falls power circuits in the form of three-phase alternating current at 2,200 volts. This voltage is transformed to 400 volts for distribution in the elevator.

grain cars) and an air compressor (used for cleaning dust from motors, floors and beams). The columns, arches and floors are made of moulded concrete.

All motors are controlled from a fireproof electrical room in the basement of the elevator by means of a switchboard from which the wires pass through iron conduits to the motors. In this manner all sparks attendant upon the starting and stopping of the motors are confined

2,200 volts. The secondary panels are equipped with three-pole, double-throw, washer-type switches; three 100-kilowatt, 2,200 volts, 300 alternating transformers. The transformers are delta-connected with taps brought out to furnish voltage suitable to start 400-volt motors.

The cleaning and clipping machinery, located in the second story of the track shed, is all driven by motors; one fifty-horse-power motor is connected by a rope

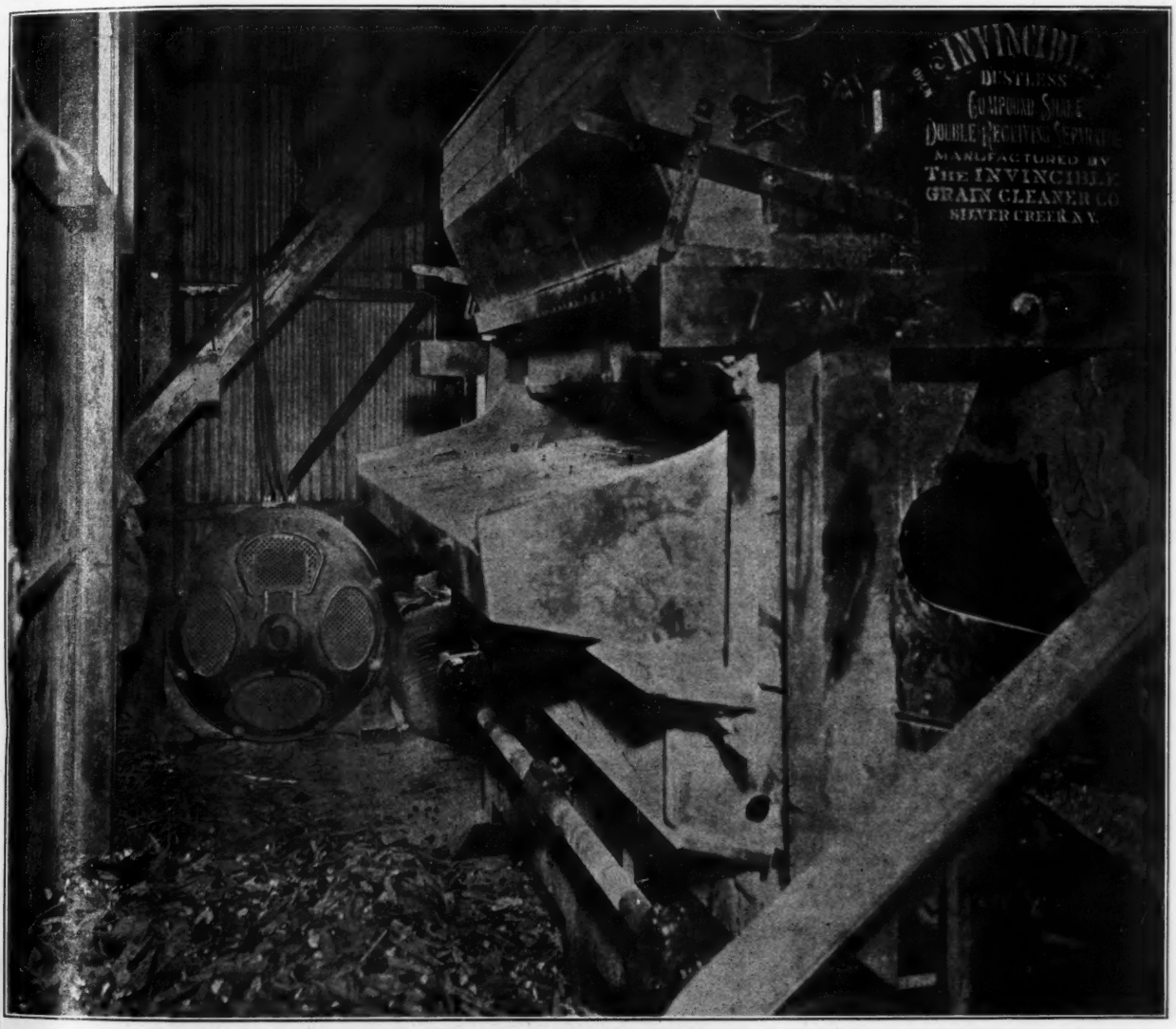


Fig. 3.—Cleaning Room, Iron Elevator and Transfer Company, Buffalo, N. Y.—Fifty-Horse-Power Induction Motor and Cleaners.

Fig. 4 shows the "basement." A ninety feet by three feet belt conveyor is shown in the foreground. This belt is capable of carrying 15,000 bushels of grain per hour. The pipes suspended over the belt are outlets to the bins. The grain empties from the pipes on the moving belt. A thirty-horse-power induction motor, three-phase, 720 revolutions per minute, operates this, and a car-puller (for manipulating and locating loaded

to this room, and all possible danger of dust explosions and fires originating from the electrical apparatus is entirely avoided.

Fig. 5 is the electrical room. The primary panel is equipped with a watt-meter, two-dial type, with electric clock attachment which directs the recording gearing from day to night dials and *vice versa;* a plunger-type, double-panel switch, Westinghouse patent, is to control

drive direct to a large clipper. A thirty-horse-power motor is also used to drive a powerful car-pulling machine in the basement.

Compressed air is distributed to all points of the elevator. This air, at a pressure of 100 pounds per square inch, is available throughout the building and is used for blowing dust out of the motors, for sweeping floors and beams and for syphoning any water that may

collect in the drain pits under the elevator. A blacksmith's forge is also supplied with air from this system.

In addition to the iron elevator just described, this company owns an older wooden transfer elevator and a very large food-grinding establishment, known as Diamond Mills, situated near the wooden elevator. The former is a railroad grain elevator of the old-fashioned wooden crib type, which has been operated heretofore by steam with great economy, owing to the fact that dust and clippings from the grain were burned as fuel. The Diamond Mills also received power for their operation from the plant of the wooden elevator. In spite of this economy, however, both establishments will hereafter be operated by induction motors, receiving current from Niagara Falls, the change being made as a result of the marked saving in cost of operation of the new iron elevator, as compared with that of the old wooden house. The power equipment for these two plants is now being installed and will aggregate about 500 horse-power, comprising the following apparatus: Three seventy-five-kilowatt, oil-insulated transformers provided with special tap from which a suitable starting voltage for the motors can be obtained.

A 100-horse-power, three-phase induction motor, and also the following motors of the same type: Three of seventy-five horse-power; three of fifty horse-power, and one of thirty horse-power.

All the electrical apparatus has been furnished by the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., and the engineering and construction work by the Macdonald Engineering Company, of Chicago.

FIG. 4.—THE BASEMENT, IRON ELEVATOR AND TRANSFER COMPANY, BUFFALO, N. Y.—THE PIPES LEADING FROM BINS AND THE BELT CONVEYOR.

Calling for Tenders.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

The Wellington City Council has decided to call for tenders from London for the construction and equipment of its electric tramways and has instructed its engineer to proceed home for that purpose.

It is his intention to travel *via* the states and examine some of the more recent tramway undertakings.

W. R. WRIGHT,
Tramways Engineer.

Wellington, N. Z., June 25.

Electric Express Line between Rome and Naples.

A committee of electrical engineers has been appointed by the Italian Government in order to come to a conclusion regarding the scheme for an entirely new line connecting Rome with Naples. This line will be double tracked throughout and electrically equipped on the third-rail system. The speed of the trains will be regulated so that the whole distance between the Italian capital and Naples will be covered in less than two hours. The terminal stations will be built at the centre of the cities, so that practically the two towns will be in very intimate communication. The country between Rome and Naples is the most rich and fertile of the whole peninsular, and, especially now that important drainage works are going on, that part of Italy will certainly become a field of wealth. Regions which at present are almost isolated will be recalled to a new era of agricultural progress.

The largest turbines in existence at the present time are under construction for the two large railway systems of London, England. These turbines will furnish power for operating an underground train service, and the seven units ordered aggregate 41,000 kilowatts, the largest unit being 5,000 kilowatts. This is by far the largest machine of this kind ever constructed, and rivals in capacity the greater proportion of large engines of the reciprocating type now in existence.

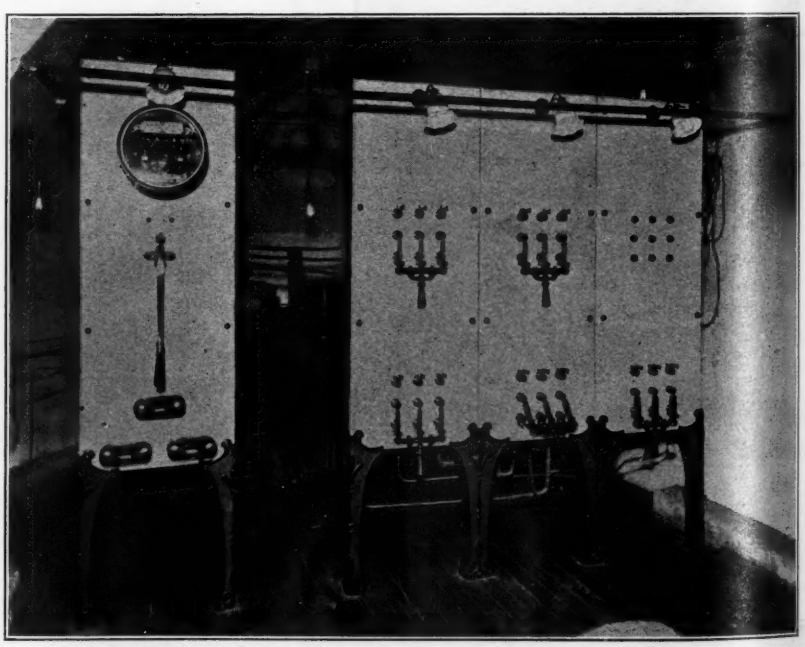
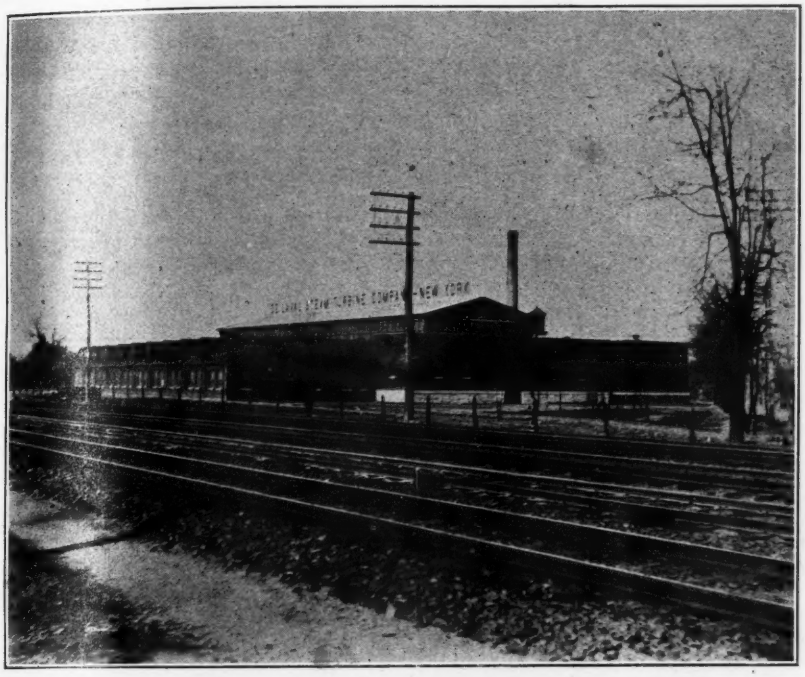


FIG. 5.—THE ELECTRICAL ROOM, IRON ELEVATOR AND TRANSFER COMPANY, BUFFALO, N. Y.

The Development of the Steam Turbine.

Some Recent Tests of a 300-Brake Horse-Power Machine.

THERE are to-day two types of steam turbines which have been found to be successful. One of these, working somewhat upon the principle of the compound engine, transforms the potential energy of the steam into kinetic energy by successive expansions. This is accomplished by leading the steam into the turbine case, where it meets a set of guide plates, and is directed by these against the buckets of a moving wheel. From these it passes to a second set of guide plates, and thence through the second wheel, and so on, the passage area increasing progressively and allowing the steam to expand on its way through the turbine.



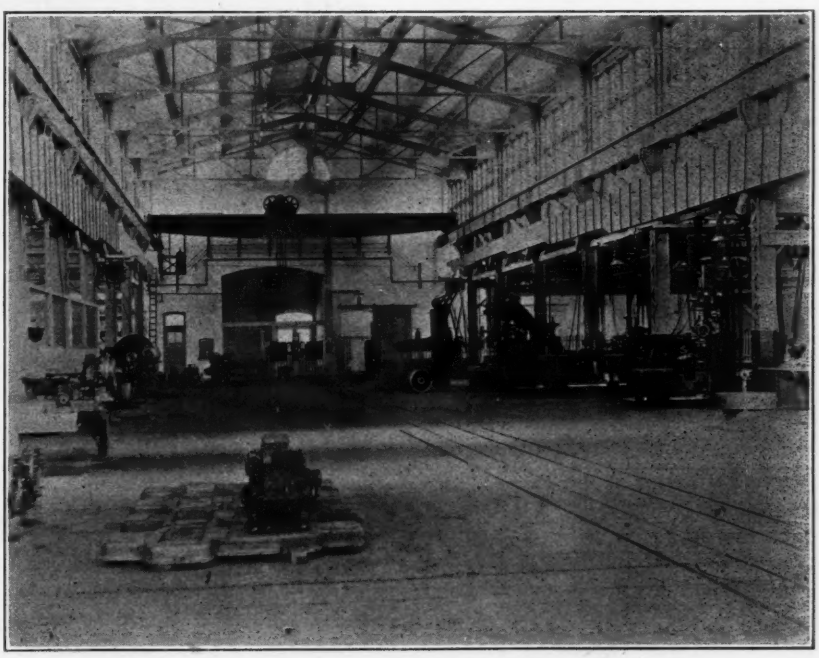
WORKS OF THE DE LAVAL STEAM TURBINE COMPANY, TRENTON, N. J.

In the other type of turbine the steam is completely expanded in the nozzles through which it is admitted to the wheel chamber. The degree to which the expansion is carried on is determined by the design of the nozzle, and can be anything desired. Thus, one shape of nozzle will deliver steam at atmospheric pressure, while another will expand to the condenser pressure. The steam leaves the nozzle as a cylindrical jet of cooled vapor. The potential energy which it possessed by virtue of its temperature and pressure has been converted into kinetic energy, and the greater part of this is imparted to the wheel when the jet impinges upon its buckets.

In this type of engine there are no sliding parts, no packing rings nor steam-tight joints. The moving part is not exposed to high temperatures, as during expansion the temperature of the high-pressure steam is reduced to that of the condenser. Here superheating can be used to the greatest advantage, as the high temperature can cause no trouble from expansion of the turbine parts. Since the jet does not change form after leaving the nozzle until it strikes the wheel, ample clearance can be allowed between the two. This turbine is a wonderfully simple machine, yet it performs its work with an efficiency comparable to that of a compound condensing engine.

The American patents for this type of turbine are controlled by the De Laval Steam Turbine Company. The works are at Trenton, N. J., where a modern factory building, 220 feet by 210 feet, has been erected. The weaver shed or sawtooth roof has been adopted, giving excellent lighting of all parts of the shop. In addition to the main structure there are a power-house, a testing room, forge room and pattern safe adjoining.

The large shop is divided by the main bay, forty feet wide, which runs the entire length of the building. This is equipped with an electric traveling crane and has a railway track running up the centre. Along the sides of this bay are placed the larger machine tools and here the heavy work is done. All of these machines are of the latest and best types



MAIN BAY, LOOKING EAST, SHOWING ELECTRIC CRANE AND MACHINE TOOLS.

and each has an individual motor drive. This enables the speed of the machine to be readily set to give the best results with the least waste of time.

Running at right angles to the main bay are the smaller bays, each twenty feet wide. The arrangement here consists in placing the smaller machine tools in alternate bays, while on the others are mounted pneumatic cranes. This plan enables the work to be brought to the tool from any part of the shop with the greatest ease. In the tool bays the machines are driven from an overhead shaft, driven in turn by a motor.

The buildings are heated and ventilated by the Sturtevant hot-air system. Compressed air, water and oil are carried in pipes to all parts of the shop. The lighting is by incandescent lamps on the three-wire system, and power is supplied to the motors from the outers.

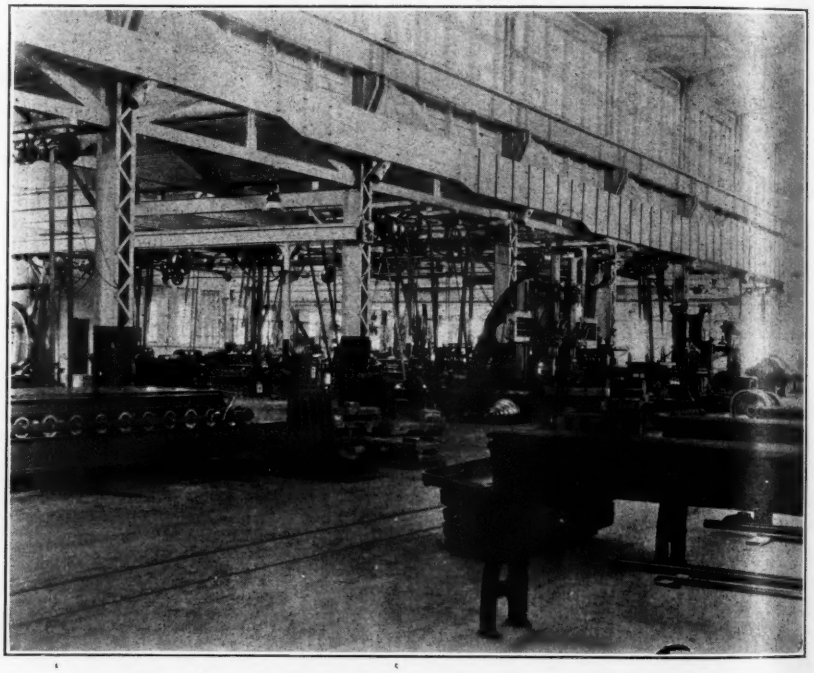
In the northwest corner of the main building is the pattern shop, and just without this, but entirely separated from the main building, is the fireproof pattern safe.

Next to the pattern shop, on the west side of the main room, is the storeroom, where the various parts of the turbine are being accumulated as rapidly as the tools can turn them out.

At the southwest corner, in another room thrown out from the large shop, is the testing laboratory. Here a complete system of piping allows any size of unit from the one and one-half horse-power headlight set to the 300-horse-power, double-generator condensing set to be quickly coupled up and tested.

Just north of the testing room is the well-equipped forge room, while the power-house lies on the other side, to the south. The power plant includes two 250-horse-power Babcock & Wilcox boilers with superheaters, a Worthington injector condenser and a 300-horse-power, double-generator turbine set. This supplies all the light and power required in the shop. This unit was put in operation last fall, and has been running continuously since without a hitch, although its gears were considerably damaged during the voyage from Sweden. An efficiency test of this unit was made during the months of May and June just passed, and a full abstract of the report is given on pages 180, 181 and 182.

In the northeast part of the building are the shop, offices and draughting rooms. South of these lies the gear-cutting room, where the large spiral gears and the double pinions are cut. In the smaller units but one pair of gears with the two pinions is used. In the larger sizes four gears are used, two on each side of the pinions. This arrangement balances all end and side thrusts on the turbine shaft. The gear room is one of the most interesting parts of the shop. The exceptionally high speed, from 7,000 revolutions per minute for the large units to 40,000 for the smallest, makes it necessary to have these gears practically perfect. The gear is made from a cast-iron disc, finished and balanced, on which is forced by an hydraulic press a forged steel rim. This is then turned up and placed in a gear-cutting machine of special design. The work done here is probably finer than that turned out by any other gear-cutting machine in the world, for while the character of the work at the Swedish factory is the same, here a gear will be finished in six hours which would require six days in the other shop. These gears do not run in oil, but are lubricated by sight-feed oil-cups.



South Side of Main Bay, Showing Large Machine Tools.

The turbine wheel is the only part of the complete machine which is not yet being made at the Trenton works, this being sent over from the Swedish works. However, it is the intention of the American company to make this as soon as the requisite machinery can be installed. The wheel itself has been designed with the greatest care. The thickness of the steel plate tapers gradually from that of the hub at the centre to that of the buckets at the rear. This gives the requisite stiffness and a uniform strength at all points. The buckets are made separate and are dovetailed into the rim of the wheel, the projecting flanges of these making a continuous smooth surface. Should one of these be broken, it can easily be driven out and replaced by new. Just within the inner end of the vanes a shallow groove is turned in the wheel, making this the weakest point of the wheel, the idea being to have a break occur along this line in case of accident, so that all detached parts will be light and do little damage.

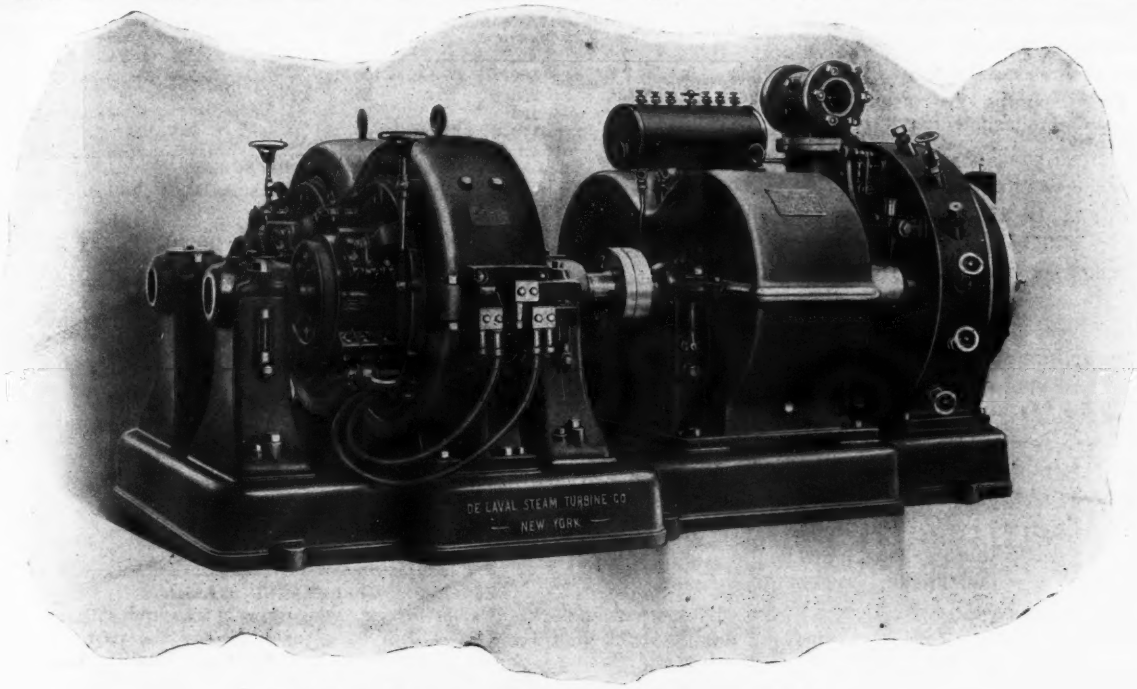
The turbine shaft, which on account of the high speed can be made slender, is flexible. This permits the turbine to revolve about its centre of gravity and prevents vibration. In the larger sizes the shaft is in two parts, set into the hub and bolted to it by flanges. In the smaller sizes the shaft is in one piece.

The proper design of the nozzle is determined by the conditions of operation. That is to say, each nozzle will take steam at a certain pressure and expand it down to a certain lower pressure. It is a simple matter, however, to equip each turbine with nozzles for all the conditions of service under which it will have to operate. In use, only the proper nozzles for the pressure in use are put in service and only as many of these as are necessary to carry the load with the best efficiency. This arrangement gives the turbine a constant efficiency for a wide

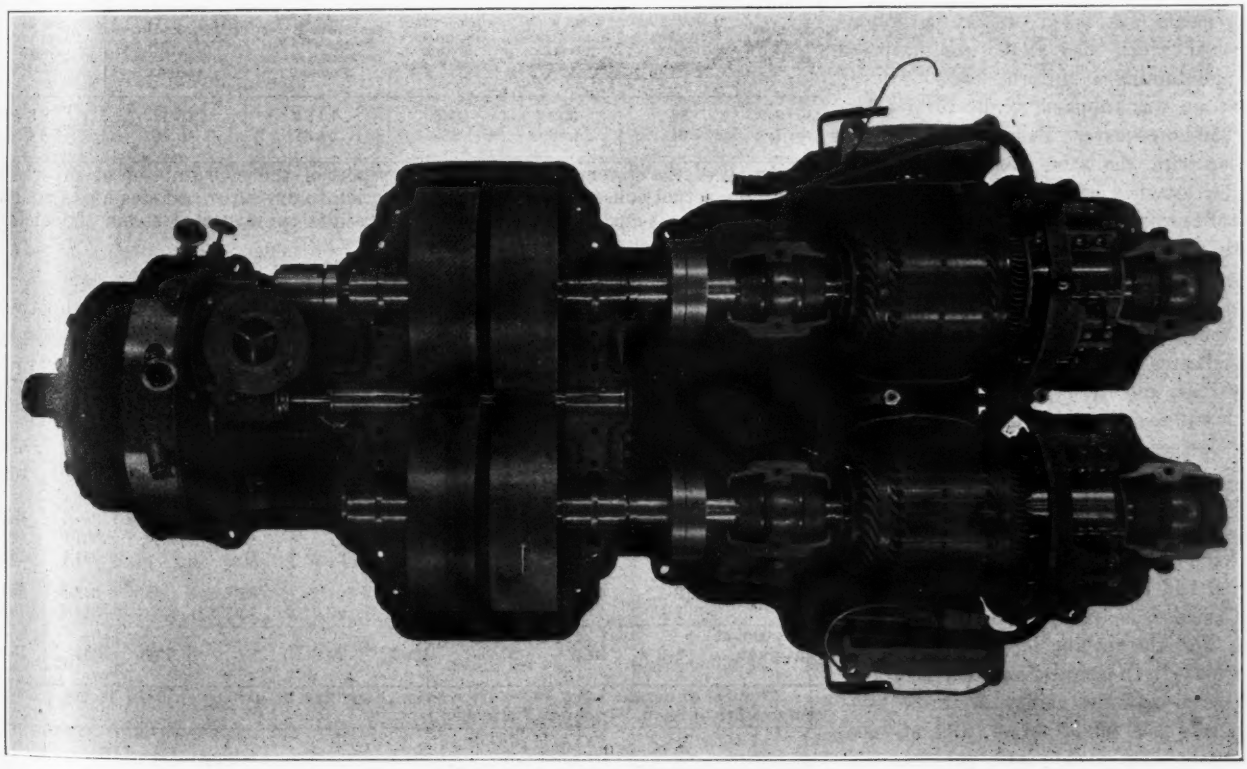
range in load, as is shown in the attached report. The nozzle is simply a brass tube with a taper hole reamed in it and with the end beveled off to clear the buckets. Stop valves are provided for opening and closing these.

valve. There is in addition an air valve, which is opened when closing the steam valve does not bring the speed down to the desired point. This admits air to the condenser and checks the speed in this way.

is needed, since there are no reciprocating parts. They are made in sizes from the one and one-half horse-power headlight set to the 300-horse-power double-generator condensing unit. The plan of driving two generators from each turbine makes an ideal set for the three-wire system of distribution.



300-Horse-Power Double-Generator Steam Turbine Set.



300-Horse-Power Double-Generator Set, Gear Casing and Upper Half of Field Frame Removed, Showing the Arrangement of the Spiral Gearing and the Automatic Governor.

A small centrifugal governor on the end of one of the gear shafts operates by opening or closing a balanced throttle

The turbines and generators are mounted on a common bed-plate and are self-contained. Very little foundation

Another exceedingly interesting piece

of apparatus developed by the De Laval company is a high-pressure centrifugal pump. This operates as other centrifugal pumps, but, due to its special design and high speed, throws a large quantity of water. These pumps are usually attached to the gear shaft. When great pressures are desired a second pump is placed on the turbine shaft. This takes discharge from the first pump and raises the pressure still higher. As these compound pumps occupy little space and operate with an efficiency far better than that of the usual plunger pump, there would seem to be a good field for this apparatus as feed pumps for boilers. It is stated that one of these compound pumps will raise water 900 feet, developing a pressure of 450 pounds to the square inch.

Below is a full abstract of the report of the test made on the 300-horse-power unit now driving the Trenton works. The engineers were Messrs. Dean & Main, of Boston, and the work was done during May and June of this year.

TEST OF A 300-HORSE-POWER TURBINE.

The output of the generator is used for driving the tools in the machine shop, but as the capacity of the shop is not sufficient to utilize the whole power of the turbine or generators, the excess over shop requirements was taken up by a water rheostat which also served the purpose of maintaining a uniform load.

Steam was supplied to the turbine by a 250-horse-power Babcock & Wilcox boiler with the same company's superheater attached and operated at a pressure of twenty pounds. Several of the tests were made with superheated steam and several without, as stated in the tabulated results of the tests. This could be done conveniently, as the Babcock & Wilcox superheater can be thrown out of use at any time, and the pipes forming it filled with water, so as to add to the water heating surface of the boiler.

The power of the turbine depends upon the number of nozzles in action and these nozzles can be opened or closed by a hand wheel on each. The machine tested had twelve nozzles, but seven gave the rated capacity. It will be seen from this that the turbine is capable of great overloads. In connection with economy of steam and the ability to throw nozzles into and out of action, it is at once apparent that each nozzle performs its function as perfectly when operating alone as when any other number of nozzles is in operation. For this reason the turbine does not change its economy of steam per indicated horse-power, if such

TABLE OF DIFFERENT LOADS AND SPEEDS WHEN USING SUPERHEATED STEAM, EXCEPT WITH THREE NOZZLES.

Nozzles Open.	Loads. Horse-Power.	Relative Loads. Per Cent.	Speeds. Revolutions per Minute.	Differences in Speeds. Per Cent.
8	352	100	750	+ 8/10 of 1
7	298	85	756	− 7/10 " 1
5	196	56	745	+ 1/10 " 1
3	119	34	751	.....

RELATIVE ECONOMIES FOR DIFFERENT LOADS.

These are shown by inspecting the tables of results, but the loads and economies are here given.

TABLE OF RELATIVE STEAM CONSUMPTIONS FOR DIFFERENT LOADS, PER BRAKE-HORSE-POWER.

Nozzles Open.	Loads. Brake-Horse-Power.	Relative Loads. Per Cent.	Steam per Brake-Horse-Power. Pounds.	Increase for Diminishing Loads, Referred to Maximum Load. Per Cent.
		Superheated Steam.		
8	352	100	13.94	
7	298	85	14.35	2.9
5	196	56	15.53	11.4
		Saturated Steam.		
8	333	100	15.17	....
7	285	86	15.56	2.6
5	195	59	16.54	9.0
3	119	36	16.40	8.1

EFFECT OF SUPERHEATED STEAM.

By comparing the results of the tests with superheated and saturated steam, the saving by the use of the former can be determined for the particular amount of superheating existing. As the tables show, the superheat steadily diminished as the load became lighter. This was caused by the fire and draught being light with the lighter loads. The superheat for the eight-nozzle load averaged 84 degrees Fahrenheit, while that for the five-nozzle load only averaged 16 degrees Fahrenheit. There is, therefore, scarcely any propriety in making a comparison for the effect of superheat, except with eight and seven-nozzle loads.

TABLE SHOWING THE SAVING BY THE USE OF SUPERHEATED STEAM FOR EIGHT AND SEVEN-NOZZLE LOADS.

Number of Nozzles in Use.	Amount of Superheat Degree Fahrenheit.	Load with Superheated Steam. Horse-Power.	Load with Saturated Steam. Horse-Power.	Steam Used per Brake-Horse-Power with Superheated Steam. Pounds.	Dry Steam Used per Brake-Horse-Power with Saturated Steam. Pounds.	Saving by Use Superheated Steam. Per Cent.
8	84	352	333	13.94	15 17	8 8
7	64	298	285	14.35	15 56	8 4

In all of the statements made in this report of the consumption of superheated steam, the actual consumption without reduction to dry saturated steam as a standard is given. This is customary, while with the results by saturated steam the moisture is deducted.

THE RESULTS.

TESTS WITH SUPERHEATED STEAM.

Number of nozzles open, eight (8). Average reading of barometer, 30.18 inches. Average temperature of room, 83 degrees Fahrenheit.

Date. 1902.	Hour.	Steam Used per Hour. Pounds.	Pressure Above Governor Valve. Pounds.	Pressure Below Governor Valve. Pounds.	Vacuum. Inches.	Superheat Above Governor Valve. Degree Fahrenheit.	Revolutions per Minute of Generators.	Brake-Horse-Power.	Steam Used per Brake-Horse-Power per Hour. Pounds.
	A. M.								
May 22.....	8–9	4833	208.3	200.6	27.2	81	....	356.6	13.55
" ".....	9–10	4936	207.5	199.3	27.2	86	....	355.7	13.88
" ".....	10–11	5083	207.7	202.1	27.2	91	....	357.8	14.21
" ".....	11–12	4976	208.3	199.4	27.2	88	...	354 1	14.05
	P. M.								
" ".....	12–1	4841	207.5	194.3	27.3	82	....	343.5	14.09
" ".....	1–2	4768	206.9	195.6	27.2	75	..	344.4	13.84
Independent average...	8–2	4906	207	198.5	27.2	84	750	352	13.94

Number of nozzles open, seven (7). Average reading of barometer, 30.07 inches. Average temperature of room, 90 degrees Fahrenheit.

	P. M.								
May 22.....	2.10–3.10	4316	207.5	196.2	27.4	67	....	299.8	14.39
" ".....	3.10–4.10	4248	207.3	197.9	27.4	61	....	297.3	14.29
Independent average...	2.10–2.14	4282	207.4	197.0	27.4	64	756	298.4	14.35

could be determined, as does a reciprocating engine. There is no range of temperature of any importance in the turbine to cause condensation of steam. The principal cause of diminished economy with lighter loads than the rated load is the fact of constant friction with all loads. At overloads there is even greater economy than with the rated load, for the reasons that extra nozzles are of maximum economy and the friction losses are constant.

The turbine exhausted into a Worthington injector condenser and the vacuum was measured by means of a mercury column connected into the exhaust chamber of the turbine.

The water used by the boiler to make steam for the turbine was carefully weighed, correction being made for the overflow when starting the injector for feeding the boiler.

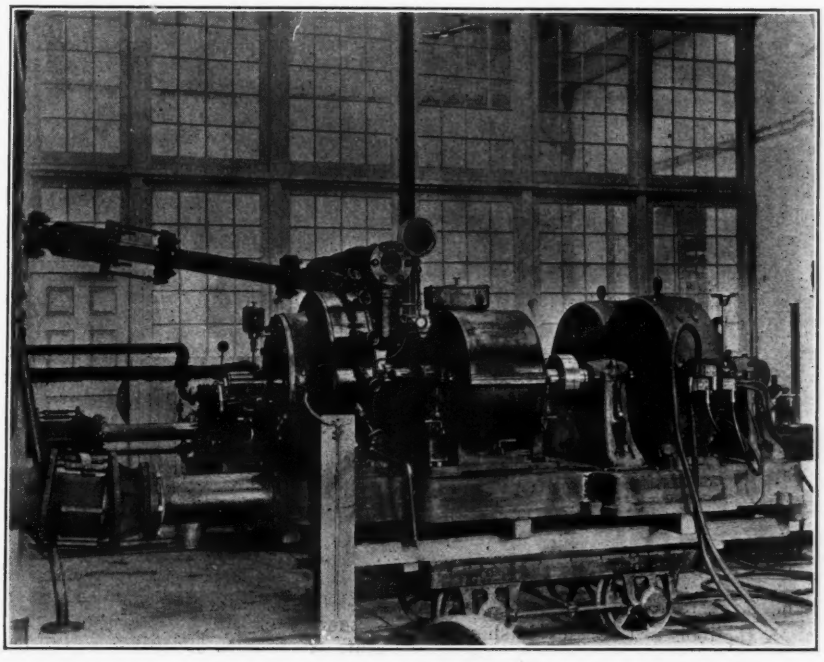
The height of the water when starting a test was noted, in order to reestablish this when desired. The water quantities were determined for each hour separately during the tests and with such uniformity in amounts that one hour would have been sufficient to approximately establish the rate of consumption of the turbine if such had been necessary. From the tables, however, it will be seen that longer periods were employed. The hourly quantities are given because it is a matter of interest to know with what degree of uniformity hourly tests can be obtained. However, the final averages only should form the means of judging the economy of the turbine.

When superheated steam was used, the amount of superheat was determined by a bare-stem Green thermometer inserted in a well of cylinder oil in the steam separator between the throttle and governor valves. When saturated steam was used the amount of moisture therein was determined by a Peabody throttling calorimeter drawing steam from the same place. The calorimeter discharge was weighed and deducted.

A separator was located in the line of steam pipe near the turbine. When superheated steam was used no condensation was weighed from the separator, but when saturated steam was used a quantity was continually discharged. This was weighed and deducted from the turbine consumption. There was a drain from the chamber which supplied the turbine nozzles, but it was considered that such steam having once entered the apparatus undergoing the test, should not be deducted from the water weighed. It accordingly was trapped and the discharge allowed to waste.

The power measurement of which was desired was the brake-horse-power of the turbine. It might have been measured by some form of friction brake simultaneously applied to each shaft on which the electric generators were secured, but, as the electrical power was needed for operating the shops, the generators were used and their efficiency determined. The electrical measurements were made by accurate instruments and their errors were determined by taking them to the works of the Weston Electrical Instrument Company, Waverly Park, N. J.

The efficiency of the generators was ascertained for each load carried. The friction was determined by driving them as motors by another generator. Other



TESTING ROOM, SHOWING 100-HORSE-POWER DOUBLE-GENERATOR SET UNDER TEST.

TESTS WITH SUPERHEATED STEAM.

Number of nozzles open, five (5). Average reading of barometer, 29.79 inches. Average temperature of room, 89 degrees Fahrenheit.

Date. 1902.	Hour.	Weight of Steam Used per Hour. Pounds.	Pressure Above Governor Valve. Pounds.	Pressure Below Governor Valve. Pounds.	Vacuum. Inches	Superheat Above Governor Valve. Degrees Fahrenheit.	Revolutions per Minute of Generators.	Brake-Horse-Power.	Steam Used per Brake-Horse-Power per Hour. Pounds.
	A. M.								
June 10....	8.45–								
	9.45	3068	199.2	196.5	27.6	8	....	195.3	15.71
" "	9.45–								
	10. 5	3010	201.5	197.2	27.4	12	....	197.3	15.26
" "	10.45–								
	11.45	3020	201.4	196.1	27 4	10	....	196.5	15 37
Independent average...	8.45–								
	11.45	3033	200.7	196 6	27.5	10	743	196.5	16.44
	P. M.								
June 10.....	1.45–								
	2.45	3107	201.4	196.7	27.4	13	....	914.8	15.95
" "	2.45–								
	3.45	3054	203.1	199.0	27.3	15	....	197 9	15 43
" "	3.45–								
	4.45	3025	202.7	197.5	27.4	19	....	194.7	15.54
Independent average...	1.45–								
	4.45	3062	202.4	197.7	27.4	16	747	196.0	15.62
Average of both tests.	....	....	....	....	....	....	745	....	15.53

TESTS WITH SATURATED STEAM.

Number of nozzles open, eight (8). Average reading of barometer, 29.92 inches. Average temperature of room, 90 degrees Fahrenheit.

Date. 1902.	Hour.	Feed Water Weighed per Hour. Pounds.	Condensation from Separator. Pounds.	Moisture in Steam at Throttle by Calorimeter. Per Cent.	Dry Steam Entering Turbine. Pounds.	Pressure Above Governor Valve. Pounds.	Pressure Below Governor Valve. Pounds.	Vacuum. Inches.	Revolutions per Minute of Generators.	Brake-Horse-Power.	Dry Steam Used per Brake-Horse-Power. Per Hour Pounds.
	A. M.										
May 23.....	8.15–										
	9.15	5289	70	2.15	5107	204.7	196.2	26.7	....	332.2	15.37
" ".....	9.15–										
	10.15	5073	70	2.15	4896	206.2	196.2	26.6	....	332.4	14.73
" "....	10.15–										
	11.15	5286	70	2.15	5104	207.2	196.3	26.6	....	332 2	15.37
" ".....	11.15–										
	12 15	5283	70	2.15	5101	207.4	198.9	26.6	....	334.9	15.25
Independent average...	8.15–										
	12.15	5233	70	2.15	5052	206.4	196.9	26.6	747	333.0	15.17

Number of nozzles open, seven (7). Average reading of barometer, 29.90 inches. Average temperature of room, 97 degrees Fahrenheit.

	P. M.										
May 23.....	12.45–										
	1.45	4675	60	2.15	4516	207.0	196.6	26 8	....	284.4	15.88
" ".....	1 45–										
	2.45	4499	60	2.15	4344	207.7	196.4	26.8	....	285.2	15.23
Independent average...	12.45–										
	2.45	4587	60	2.15	4430	207.3	196.5	26.8	746	284.8	15.56

Number of nozzles open, five (5). Average reading of barometer, 29.83 inches. Average temperature of room, 97 degrees Fahrenheit.

	P. M.										
May 23.....	3.00–										
	4 00	3483	51	2.15	3 58	207.5	196.5	27.3	....	194.8	17.24
" ".....	4–5	3219	51	2.15	3100	207.8	195.1	27.4	....	195.6	15.85
Independent average...	3–5	3351	51	2.15	3229	207.6	195.8	27.35	751	195.2	16.54

TESTS WITH SATURATED STEAM.

Number of nozzles open, three (3). Average reading of barometer, 29.81 inches. Average temperature of room, 80 degrees Fahrenheit.

Date 1902.	Hour.	Feed Water Weighed per Hour. Pounds.	Condensation from Separator. Pounds.	Moisture in Steam at Throttle by Calorimeter. Per Cent.	Dry Steam Entering Turbine. Pounds.	Pressure Above Governor Valve. Pounds.	Pressure Below Governor Valve. Pounds.	Vacuum.	Revolutions per Minute of Generators.	Brake-Horse-Power.	Dry Steam Used per Brake-Horse-Power per Hour. Pounds.
	P. M.										
June 10.....	6.35–										
	7.35	1996	33	2.15	1921	201.1	196.5	28.1	...	115.0	16.70
" ".....	7.35–										
	8.35	2098	33	2.15	2021	201.6	198.9	28.1	....	122.0	16.57
" ".....	8.35–										
	9.35	1984	33	2.15	1909	201.7	198.4	28.1	....	121.5	15.71
Independent average...	6 35–										
	9 35	2026	33	2.15	1950	201.5	197.9	28.1	751	118.9	16.40

All barometer readings are reduced to 32 degrees Fahrenheit.

losses were computed by well-known methods and under the actual conditions of temperature, speed and output.

No tests were made to ascertain instantaneous effect in speed of change of load, or to see how quickly the normal speed was regained after the change. In regard to the permanent effect of change of load on speed, this can best be observed from the data given in the tables of results shown above. The speeds and loads are here tabulated for convenience with percentages of variation of load and speed referred to these with eight nozzles in operation.

Polycyclic Distribution of Electrical Energy.

The Arnold-Bragstad-La Cour system is described in a serial in *L'Electricien*. In all alternating-current installations intended to furnish light and power the choice of frequency becomes difficult. High frequencies are better for lighting, while low frequencies give the best results for motor operation. In selecting the number of phases the motors alone are to be considered, as the single-phase system gives the best results for lighting. Further, the preferred methods for lighting and power distribution differ, and the varying calls of the motor service cause objectionable fluctuations in the lamps. It was to overcome these difficulties that the Arnold-Bragstad-La Cour system of transmitting superimposed currents of different voltages and frequencies was devised. It is shown that by introducing the secondary current for lighting at the proper point in the primary power system, all reaction between the two can be avoided. For a three-phase star system, without transformers, the single-phase current is introduced by a single line connecting the neutral points. In a single-phase system the secondary line is connected to the middle points of the single-phase armature windings. For the two-phase system the single-phase current is introduced at the central points of the two armature windings.

With these arrangements the inductive effect of the secondary current in the primary polyphase system is neutralized. The losses and line drop in each system are independent of the load on the other. When transformers are employed these must have two primary or secondary windings, as the case may be. In Bedell's system these were not provided, and as a consequence the mutual inductance caused a large voltage drop. In this system the windings are so arranged as to avoid this. Diagrams of the windings are shown for generators and transformers. In the three-phase system three single or one polyphase transformer may be used.

The Standard Steel Car Company is equipping its new plant for electric driving throughout. A recent purchase from the Westinghouse Electric and Manufacturing Company comprises two 375-kilowatt, alternating-current generators, one 400-kilowatt, direct-current generator, and a 300-kilowatt rotary converter for use as a connecting link between the two. This company has also purchased about fifty induction motors which will be used largely for direct connection to machine tools.

Electrical Notes from Europe.

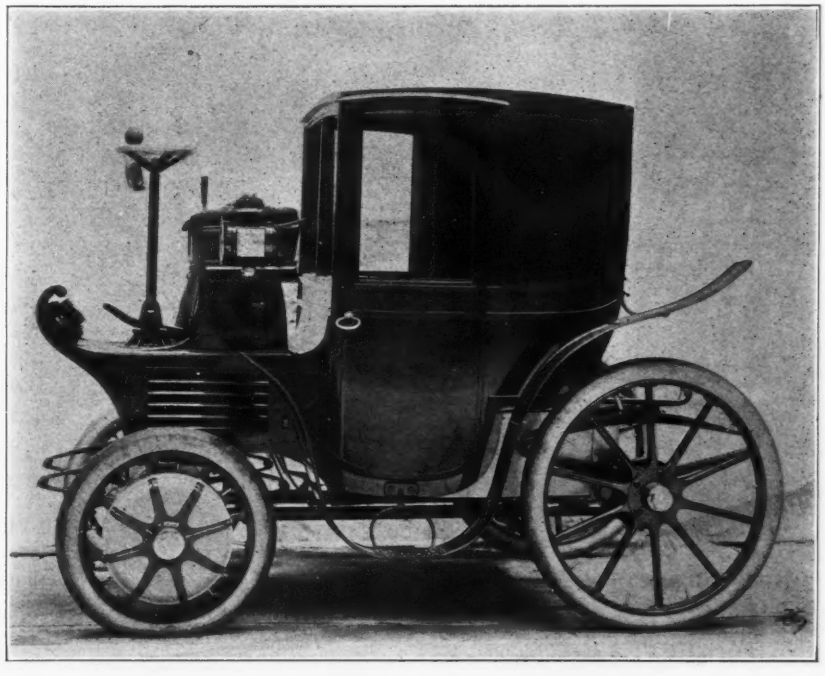
(By Our Special Correspondent.)

AN INTERESTING series of electric vehicles has been designed by the Lohner-Porsche Company, of Vienna. In these electromobiles each of the front wheels is provided with an independent motor, doing away with the transmission mechanism which always causes a considerable loss of energy. The constructors have gone still further and have built the motor directly into the wheels. The armature crown, which will be observed in the engravings, is exterior and supported directly upon the spokes of the wheels, while the multipolar field which revolves within it is fixed on the end of the axle. As each wheel has its own motor, the differential mechanism is suppressed, and the whole arrangement is reduced to its simplest terms. With the usual transmission devices from the motor to the wheel, whether in an electric or petrol system, it may be estimated that from forty to sixty per cent of the power is lost in the transmission, while in the present case the constructors claim an efficiency of eighty-five per cent. The speed is regulated by a controller which is operated by a lever at the right hand of the conductor. By different combinations of field, armature and resistances the vehicle can be given any speed from that of a walk to forty miles an hour. The arrangement of the steering wheel will be noted in front of the seat; it operates the front axle by a worm-gearing. For short distances, Planté batteries are preferred, but above thirty miles a pasted-plate battery is used. The batteries are well concealed inside the carriage-body, and the vehicle has a light and elegant appearance.

The engravings show three types of Lohner-Porsche electromobiles. The first is a Mylord of five to twelve horse-power, which carries a Planté battery for distances within twenty-seven miles, and above that uses pasted plates. In the latter case it will cover seventy-two miles on a single charge. The coupé shown in the figure has about the same power and battery capacity. The controller allows for five speeds, with a maximum of twenty-one miles an hour. A large vehicle is the break of sixteen places, in which the battery is carried underneath the body in a series of boxes which may be removed separately and are connected on the outside by short cable sections. For distances up to twenty-one miles Planté cells are used, and pasted plates up to eighty miles. This vehicle has five speeds with a maximum of twelve miles an hour.

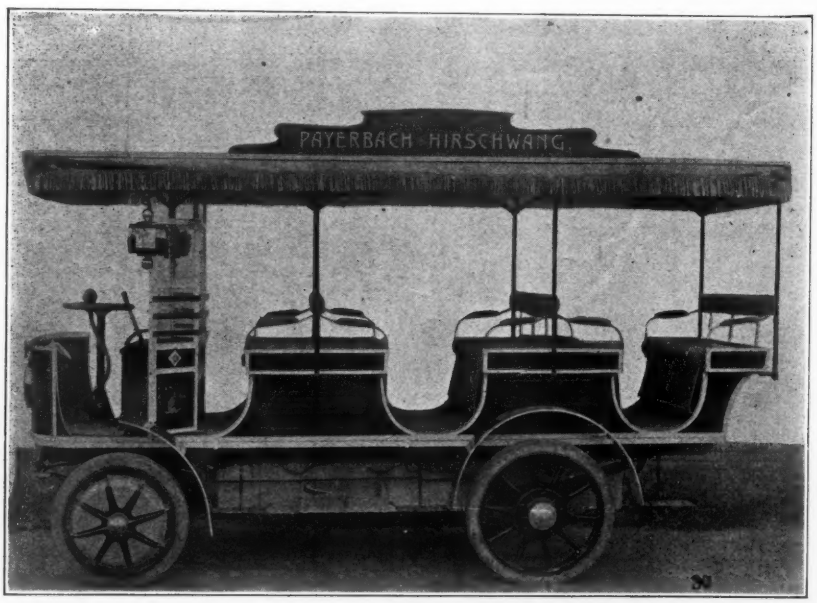
MYLORD TYPE—PETROL-ELECTRIC AUTOMOBILE.

The same company has brought out a combination "petrol-electric" vehicle. For several years past various attempts have been made to combine the electric and gasoline systems in an automobile which would thus have the advantages of both. The gasoline motor, in spite of its general adoption for automobiles, has certain disadvantages which can not be overlooked. For instance, it can not be compared to the electric motor for quiet running, and its efficiency is not high. The power transmission from the motor to the wheel and the speed-changing mechanism involve a waste of energy. The electric system, using a controller to give the different speeds, is much more elastic and easy to manœuvre. The two main drawbacks of the electromobile are, of course, the use of heavy batteries and the limited distance covered by the vehicle. Accordingly



PETROL-ELECTRIC AUTOMOBILE—COUPÉ.

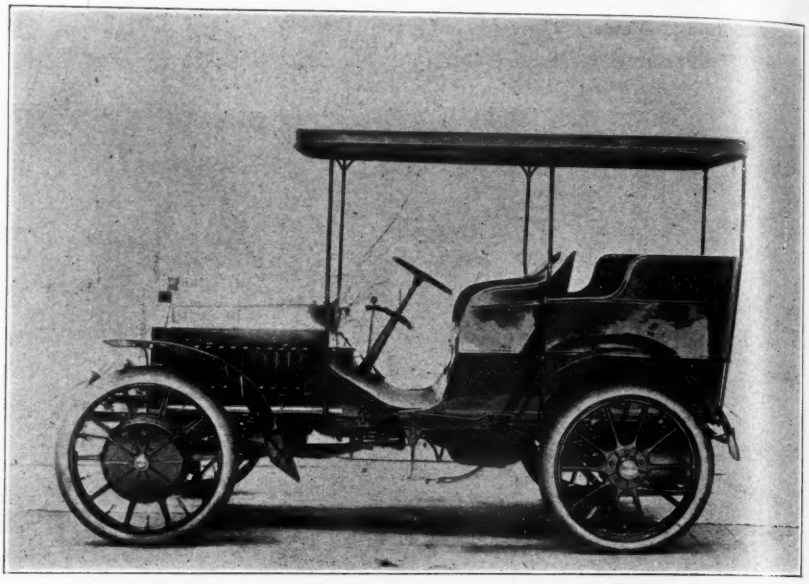
several inventors have devised systems in which a petrol motor, generally of smaller size than ordinary, is used to drive a dynamo. The current goes to the motors of the vehicle, just as in an ordinary electromobile. A small battery of accumulators is connected in parallel on the dynamo, and its energy is used to help out the latter when its power is not sufficient, for instance, in mounting heavy grades. The dynamo keeps the battery always charged when running on a level, and in this case the petrol motor alone is sufficient to propel the vehicle. In case of extra effort the battery may be instantly thrown in and its added force will nearly double the power, at least in the case of the Lohner-Porsche type. The arrangement may appear somewhat complicated, as we now have a gasoline motor, a dynamo, a set of batteries and an electric motor, and the weight also would appear greater. But it must be remembered that the gasoline motor of an ordinary automobile is quite heavy, in spite of the efforts which have been made to reduce the weight, especially as in a large-sized car a motor of fifty or sixty horse-power may be needed to give the required margin of power, when in fact only twenty or twenty-five horse-power is used in ordinary cases. The efficiency of the motor, running thus at a light load, is greatly reduced; this efficiency will be increased, therefore, by using a motor which gives but a small margin above the average power, utilizing the excess to charge a battery while in normal running, and the latter will add its energy in the exceptional cases when the vehicle needs it.



Break for Sixteen Persons—Petrol-Electric Automobile.

The petrol-electric system is not more complicated than the gasoline automobile if the differential and the speed-changing mechanism is taken into account. A vehicle thus constructed has many advantages, as it possesses the easy and silent running and the facility of speed-changing by controller, which are peculiar to the electromobile, and at the same time will cover long distances which would be impossible with the former. As there are two independent sources of energy, one of these can be brought into use in case of a breakdown to the other. Another good point is that the petrol motor can be thrown off instantly by the simple movement of a lever, and the vehicle is then propelled by the battery alone, as in passing through cities, etc.

Several types of petrol-electric vehicles have been built by the Lohner-Porsche Company before arriving at the 1902 model, which is shown in the engraving. It is a "Duc-tonneau" of four places. The motors are mounted directly on the front wheels as before, but have some improvements in detail, being also somewhat smaller in size. The petrol motor, mounted in the front box, is of the Mercedes type (Daimler make), which has already proved so successful in the petrol racing cars. The motor, which works generally at constant speed, is directly connected to the dynamo by a shaft which passes backward, and is provided with a flexible coupling to take up the shocks of the vehicle. The dynamo is protected below by a water and dust-tight case; it is a six-pole machine and has a maximum capacity of twenty-one kilowatts. The current goes to the controller, from which it is distributed to the motors. The excess of current is used to charge a set of accumulators located in the rear part of the carriage-body. The controller is placed under the footboard and is worked by a lever below the steering-wheel. There are three main points on the motor field and armature, and between these are intermediate resistances giving a total of fourteen speeds. By means of a switch the current may be reversed at any of these speeds. The Planté form of battery is preferred, as it gives a great supply of energy for a short period, and in fact the energy can be nearly doubled when it is required to mount a heavy grade. As the battery is always kept charged by the



Petrol-Electric Automobile—1902 Model.

dynamo when on a level, it takes only a small quantity of energy to keep it up to voltage.

The electric motor of the "Nizza" (Nice), 1902, type has some novel features, but on account of the patent questions a full description must be reserved for a future article. The interior field, fixed to the axle, has twelve poles, and the armature turns on the exterior upon specially designed bearings.

The vehicle can be braked by using the action of the motor, which is thrown on short-circuit and thus develops a powerful braking action. Besides, a band brake is applied to the rear wheels by a foot-pedal which also cuts the current. The disposition of the vehicle allows the use of the same size wheel for front and rear (thirty-five-inch diameter with three and one-half-inch pneumatics) and thus only one size of the latter need be carried as a reserve, which is a decided advantage. The 1902 type will give a speed of thirty-five miles an hour on a five-per-cent grade, and from fifty to sixty on a level road. The petrol motor is light, being built for twenty-five to thirty horse-power, but with the addition of the battery the vehicle will develop fifty or sixty horse-power. When in the cities it can go several miles, using the battery alone, with the advantages of quiet running, then when the country is reached the petrol motor is thrown on. This facility of changing may be of great use when it is desired to pass by horses without frightening them, as by simply throwing a lever the petrol motor is cut off and the vehicle runs silently with the battery.

Another feature of the vehicle is its use in military operations. An ordinary electromobile is scarcely adapted for military manœuvres owing to the difficulty of charging the batteries. This drawback is overcome in the present type, and thus a source of electric energy is at hand, which may be put to different uses. The dynamo is sufficient to work two large arc projectors of eighty volts and eighty amperes, which may be used as searchlights to explore the enemy's posts. It will also supply twenty arcs of ten amperes or 200 incandescent lamps of sixteen candle-power, which may be used with temporary circuits for lighting the camp, field-hospitals, etc., besides the batteries provide a source of X-rays for surgery.

An interesting hydraulic plant is that which has lately been constructed to utilize the power of the Rhone at Saint Maurice and transmit the energy to Lausanne, over a distance of thirty-five miles. Contrary to the usual practice, direct current at 23,000 volts is used for the line and is then transformed at Lausanne to three-phase current, according to a system worked out by M. Thury, a well-known constructor. The dam across the Rhone is 280 feet long and gives a fall of 120 feet, representing about 14,000 horse-power. An extensive system of canals and basins is used, the distance from the fall to the turbines being about two miles. An open canal takes the water from the dam, passing along the Rhone, from which it is separated by a masonry dike. The canal leads to an extensive reservoir of 4,500 square yards surface, where most of the sand and mud is deposited. From here starts a second canal, partly closed and partly open, passing under the Jura-Simplon railway and the St. Barthelemy mountain torrent, and arriving at a second reservoir which further clears the water and acts also as a regulator of level. A penstock, eight feet in diameter, built of sheet iron tube, resting on masonry pillars, brings the water to the turbine station. There are five turbines of 1,000 horse-power each, working at 300 revolutions per minute under a 102-foot head, besides two smaller turbines of 120 horse-power. The turbines drive ten direct-current dynamos in all, mounted in pairs on the same shaft with one of the turbines. These are Thury machines, giving 2,300 volts and 156 amperes. The smaller turbines drive three-phase alternators for local use. The main transmission line, thirty-five miles long, crosses the Rhone, the Jura-Simplon road, passing along the Rhone Canal, and reaches Lausanne. A copper cable of 150 square millimetres section is used for the line, supported on porcelain insulators. After feeding a 300-kilowatt motor in the Paudex cement factory, the line comes to the station at Lausanne, where it is transformed to three-phase current. The outfit consists of five motors of 300 kilowatts, working at 150 amperes and 2,150 volts. Four of the motors drive each triphase alternator at 3,000 volts for the distribution circuits of Lausanne and suburbs, while the fifth motor drives a 300-kilowatt generator for the city tramways.

M. Branly has devised a new form of coherer which he claims to be much more simple and reliable than the ordinary type consisting of a tube filled with metal filings. The latter has the advantage of being easy to construct, but after making a considerable number of experiments with filing tubes, M. Branly finds that they are not as reliable in their action as they should be, probably on account of the great number of contacts between the filings and the effect of the repeated shocks upon the surface of the metal. He finds that a contact between a polished and an oxydized metal forms a coherer which is much more regular in its action, and at the same time is quite sensitive, even more so than the filing tube. By using a coherer of this form he was able to suppress the independent striking device and also increase the speed of transmission. The apparatus at the receiving station thus becomes considerably simplified, as it consists only of the coherer and the Morse receiver with its relay. The new coherer has the form of a tripod; a metal disc has fixed in it three metal rods which project vertically, these being pointed and slightly rounded at the ends. He makes the points of tempered steel and they are first polished, then oxydized at a determined temperature. The tripod rests upon a lower disc of polished steel, forming thus three contacts. The degree of oxydation of the points and the polish of the metal are the influencing factors in this apparatus. The slight layer of oxide is rather durable and will last for several months. Two circuits are used; in the first a battery of one-half volt has one pole connected with the upper limit-screw of the Morse receiver; below the screw is a platinum tongue fixed to the armature, into which the current passes, and thence to the coils of the relay, the coherer, and returns to the battery. The second circuit includes the magnets of the Morse receiver and the relay contact which closes their circuit through a battery. When a signal is received the coherer becomes conducting in the usual way and the first circuit becomes closed. This causes the relay to act and the armature of the receiver is attracted; by its descent it breaks contact between the upper screw and the tongue, but continues its movement by the momentum acquired and strikes the lower screw. The tripod is connected mechanically with the screw and the slight shock which it receives is sufficient to cause a decohering action and the circuit is opened. The armature is lifted again by the spring and is ready to act on a second impulse. As the shock needed for the coherer is very slight, the play of the armature may be reduced, thus increasing the speed of transmission. In practice the tripod, which is of small size, is mounted upon a shelf formed by the extension of the lower part of the receiver. In this way it receives a shock every time the armature strikes the lower screw. The coherer is removed from the influence of the sparks sent from its own station by an auxiliary electro-magnet which is placed above it and serves to lift the whole tripod off the lower plate while the post is making the transmission.

Paris, July 26. C. L. DURAND.

News from Great Britain.

(By Our Special Correspondent.)

THE question of modifying the present laws of the land in so far as they relate to applications of electricity which has, during the past year, formed the subject of the deliberations of a committee of the Institution of Electrical Engineers was recently also the subject of a deputation to the Board of Trade. Just why Lord Salisbury, the Prime Minister, should have placed the onus of receiving such a deputation upon the latter body is not quite clear, inasmuch as no exception is being taken to the construction placed by the Board of Trade upon the existing regulations. The general feeling is that a thorough enquiry should be made by a royal commission with the object of determining to what extent the present conditions of electric supply are hampered and restricted by regulations made years ago when the industry was in a far different condition to that obtaining at present. As Mr. Swinburne, the president of the Institution, who led the deputation—after having been introduced by Lord Kelvin—put it, in 1882 there seemed never any prospect of electricity being distributed over anything more than a parish, and this being so the Electric Lighting Act of 1882 was framed on parochial lines. But, of course, the latest exploits of the power distribution companies, which deal with thousands of square miles, has changed all this, but the legislation remains the same. A similar state of affairs happens in the case of tramways. In all controversies on private enterprise *versus* municipal trading, the most impartial observer must notice the great legal right given to local authorities in anything appertaining to a public convenience, and in tramway matters this right of veto is strongly pronounced. Before a trading concern can come before Parliament with a scheme for a tramway in any district, the consent of the particular municipal body must be obtained else the proposal will not be looked at. And in certain instances, such as where the county councils are the road authority, two consents have to be obtained, and the deputation was only making a reasonable request in asking that the municipal bodies should oppose any scheme as an ordinary opponent and that all schemes should be considered on their merits irrespective of the attitude of the municipalities. Many instances of the arbitrariness of local authorities in respect to tramways are to be found, a notable one being at Wolverhampton, where, after putting it upon a certain body of tramway promoters that their electrical energy should be taken from the corporation supply works, such a prohibitive price was asked for it that the scheme was dropped—apparently just what the corporation wished. Many other things were touched upon by the deputation, such as the use of overhead wires instead of costly underground mains, and also the limits of the size of converters and trunk mains. The result so far is only what one fears to be the usual fate of such applications, *viz.*, the government practically agrees that something of the sort asked for is necessary, but are not particularly keen on giving it—mindful of the strength of municipal opposition. Municipal trading in competition with private enterprise is distinctly good for the public, but to start the latter handicapped in the manner indicated above tends to restrict the competition and place a monopoly in the hands of local authorities which is distinctly bad for the ratepayers. As something in the nature of a report, however, will be issued, nothing more need be said at present.

The fire at the stores of the General Electric Company, which resulted so disastrously to the employés, has raised a perfect hubbub, and the daily papers have all been full of comparisons between our methods of dealing with fires in high buildings and those employed in America and on the Continent. But whatever may be the merits of the systems in different countries one can not deprecate too strongly the criticisms hurled at the fire brigade as a brigade. No doubt something will be done when the inquest on the unfortunate victims has been concluded. In the meantime, the General Electric Company's works have not been destroyed, as has been cabled abroad, but only a very small portion of its London stores, which in no way will affect the business.

An indication that electricity is becoming more and more the "poor man's light" is afforded by an order for some hundreds of "slot" electric meters by the Northern Counties Electricity Supply Company, a concern which is dealing with a large area in the northern colliery district of Great Britain.

The extension of electricity supply in London continues at a great pace, and the latest addition to the existing means of supply was recently opened at Haggerston as a supplementary power-house to the present system of the Shoreditch Borough Council. This body, it will be remembered, was the first in the kingdom to start up a dust destructor in conjunction with an electrical undertaking, and although this side of the question has not fulfilled every anticipation, an increasing demand for the current continues, the neighborhood being a peculiarly manufacturing one with poor-class residents.

Orders for the equipment of the power-house for the railway lines now undergoing electrification at the hands of Mr. Yerkes continue to be steadily given out, the most recent one being to the British Thomson-Houston Company for the switchboard, which will operate the ten 5,000-kilowatt, 11,000-volt generators. This consists of forty-seven black enameled slate panels, *viz.:* four generator exciter panels, one exciter feeder panel, two rotary converter panels, one direct-current generator panel, one storage battery panel, two direct-current feeder panels, one low-tension transformer panel, three induction motor panels, twelve feeder panels, ten generator instrument panels, and ten controlling panels. Oil switches will control the feeder and generator circuits. They will be capable of opening a dead short-circuit of the entire station, and will act as automatic circuit-breakers in the feeder circuit. They will also be capable of opening the circuit in the event of a reversal of current, thus forming an automatic circuit-breaker without the interposition of high-tension fuses.

Tramway proposals in and around London this session have been providing Parliament with more than the usual amount of discussion. After defeating two divisions in the House of Commons, the London County Council's idea of a tramway along the Embankment has received a severe check at the hands of the lords, inasmuch as the House of Lords Committee to which the bill has been referred has received an instruction to strike this particular line out. The London County Council will therefore be left in the somewhat unhappy position of having a subway tramway coming from the north run-

ning onto the Embankment without any physical connection with any other means of communication running south. In the west of London, the London United Tramways Company, flushed with success in connection with its tube railways, is making provision for local improvements and so gaining the consent of the various local authorities, with the result that another bill for extensive new tramways has been passed which will run right out into the country and seriously compete with the steam railways.

The coronation illuminations, which, after a bad start, proved to be much more largely electrical than was at first supposed, have not yet had a chance to display themselves, owing to the unfortunate and sudden illness of the King. One of the neatest and most compact of all is the Canadian triumphal arch in Whitehall, in the decoration of which some thousands of lamps were fitted. The Electric Lighting Boards Company did a large business, and the chief sufferers through the postponement would appear to be the supply companies.

The International Tramways Congress, which is running concurrently with the Light Railways Exhibition at the Agricultural Hall, London, began a couple of days ago, and by the programme, as is often the case with such functions, the members are asked to get through an inordinate amount of work in the shape of business meetings, dinners, receptions, visits, etc., of which I will have more to say in my next letter. As regards the exhibition, which is only the second of its kind ever held in Great Britain, a much more representative show has been got together than on the first occasion, which, by the way, was a pronounced success. The largest exhibitors are the Westinghouse company, with a length of trolley tramway running the whole length of the hall and shown in actual operation, the British Thomson-Houston Company, Dick, Kerr & Company, Ferrante and several others of our large manufacturers. American goods in the shape of such details as bonds, etc., are to be seen in great profusion, and the extension of the time of holding the show from seven to twelve days is a wise one. The presence of so many foreign delegates in London attending the Tramways Congress lends an international flavor to the exhibition, and we all hope that a more accelerated improvement in the facilities at present afforded for mechanical traction on public roads will follow as a consequence.

News comes from India that efforts are being made in that British possession to introduce a complete system of legislation for regulating the supply and use of electrical energy, based upon the Electric Lighting Acts in force in Great Britain. Very little is heard of electrical matters in India, where, I believe, no legislation whatever exists in connection with electricity, but in the happy event of the Indian Electricity Bill, as it is called, being passed, investors should feel more safe in coming forward.

For some years there have been a few municipal electric supply undertakings in Great Britain which have persistently, year by year, failed from the commercial point of view, and thus afforded the enemies of the electric light, for instance, a convenient peg upon which to hang an argument against us. One of the worst offenders in this respect has been the Salford corporation electric supply undertaking. At various periods throughout the history of this concern "events" have happened which have created the impression that the management was not working with the maxima of harmony, and the last such "event" was that the resident engineer was called upon to resign, and was eventually refused an opportunity of coming before the committee. A few months ago, however, the electric auditors of the borough made a request that a competent person should be called upon to enquire into the administration of the undertaking and a judge of the high courts was appointed. A long enquiry revealed an unpleasant state of affairs in which everyone seemed to be accusing everybody else of shady tactics in respect of contracts and orders. In summing up, the judge (whose final report has yet to come), without accusing any one of deliberate intention, thought the proceedings would not enhance the reputation of the consulting engineers nor one or two of the councilors. It is to be hoped that municipalities will take the lesson to heart.

The much vexed question of real and imaginary damage from vibration due to the construction and working of tube railways in London has been met in a very satisfactory manner by Parliament this year, which should greatly simplify matters for the railway companies in future. In all new tube railway bills a standard clause will be inserted giving all land and property owners along the line of route the right to lodge a claim for damage within two years after the date of the opening of the railway. If the company disputes the claim then the matter is to be settled by an arbitrator appointed by the Board of Trade if need be. This is much more expeditious than having a whole sheaf of clauses in every bill for the protection of almost every house.

The electrification of the railways of which Mr. Yerkes has secured the control is being pushed forward with the object of completing the work within the next twelve or eighteen months. As yet no work has been commenced as far as the running track of the inner circle is concerned, but orders for the power-house continue to go out. Among these is a supplementary order to Messrs. Babcock & Wilcox for sixteen further boilers, aggregating some 8,000 horse-power, and a number of E. P. S. storage batteries.

In pursuance of its policy of getting at loggerheads with practically all the municipalities consequent on the passing of the Telephone Act of 1899, the National Telephone Company introduces a bill this session seeking to confer certain rights upon itself in respect of wayleaves at Hull, which the corporation has refused. The committee, however, immediately threw out the measure on learning that the corporation, in stopping the company in this matter, had merely terminated an agreement by the ordinary six months' notice, and were, therefore, well within their rights in so doing.

The coronation illuminations which have had very little chance of being displayed, were, from an electrical point of view, of a splendid character. Incandescent lamps by the thousand, as well as arc lamps and Nernst lamps on the Canadian arch in Whitehall, would have produced an effect which would have somewhat surprised our good friends, the gas companies, and would further, in the opinion of those capable of judging, forced the load on the London electric supply companies up to a point equal to the top winter load. In this respect alone the King's illness has meant the loss of many hundreds of pounds.

London, July 26. A. W.

When liquid silicon hydride is decomposed by a series of electric sparks amorphous silicon is obtained, possessing reducing properties toward potassium permanganate, sulphate of copper, mercury perchloride and chloride of gold.

DEPRECIATION IN TELEPHONE PROPERTY—I.

A SERIES OF PAPERS ON AN IMPORTANT TELEPHONE PROBLEM.

BY FRED DE LAND.

At the closing session of the first convention of the Interstate Telephone Association, held in Chicago, last April, "a sharp discussion followed the reading of Dr. Herr's paper," on the "Cost of Construction and Maintenance of Telephone Plant." During this discussion "a delegate from Louisville declared that Dr. Herr's statement that the value of a plant depreciated ten per cent in a year was erroneous and so hurtful to the interests of the independent companies that he advocated the elimination of the statement from the paper before publishing it with the other records of the conference." Several delegates asserted that an allowance of three per cent was sufficient. Finally, on motion of Mr. Conklin, the following resolution was adopted:

"*Resolved*, That it be the sense of this convention that the depreciation in a well-constructed and well-engineered telephone plant should not exceed five per cent per annum."

For more than fifteen years experienced telephone men have held that depreciation signifies more than maintenance or repairs; it means in its broadest sense a constant charge against the property and consequently a legitimate deduction from gross receipts before the true earning power of the property can be determined. These telephone men of wide experience, who have striven with every phase of the problem, know full well that taken as a whole all the property employed in the telephone business, excepting the buildings and the ducts, has been wholly replaced on an average of at least once in ten years. And the records of many independent companies show even a more frequent replacement. Thus the only conclusion that many thoughtful telephone men can come to is that Dr. Herr was right in stating, as reported, that an allowance of ten per cent per annum for depreciation must be made before the true earning power of a plant could be determined.

This allowance of ten per cent is not only reasonable and just, but absolutely necessary if the plant is to be properly and honestly maintained. Moreover, the highest court in the land has sanctioned the including in operating expenses of proper charges to cover the lessening in value through depreciation; hence there is ample legal justification for including this allowance of ten per cent when determining what rate will yield a profit on the hazardous investment.

In one case before the United States Supreme Court (108 U. S., 277), where the court was considering whether, when money has been lost by a railroad company through depreciation of its property, such losses may be deducted from the earnings as a part of the expense account, the court held that "the judgment of the circuit court is reversed and the cause remanded, with instructions to deduct from the amount of earnings, as ascertained upon the former trial, the items of $22,000 depreciation in the value of bonds, and $5,225 depreciation in the value of cotton-press stock, together with such other sums included in the items of $51,155.44, depreciation in book accounts and choses in action, and $106,014.62, depreciation in value of the street connection track, as upon further hearing shall be found to represent losses accruing to the company between certain dates."

Again, Mr. Justice Harlan (in 174 U. S., 757) held: "The contention of the appellant in the present case is that in ascertaining what are just rates, the court should take into consideration the cost of this plant, the cost per annum of operating the plant, including interest paid on money borrowed, and reasonably necessary to be used in constructing the same, the annual depreciation of the plant from natural causes resulting from its use, and a fair profit to the company over and above such charges for its services in supplying the water to consumers, either by way of interest on the money it has expended for the public use, or upon some other fair and equitable basis. Undoubtedly all these matters ought to be taken into consideration, and such weight be given to them, when rates are being fixed, as under all circumstances will be just to the company and to the public. The basis of calculation suggested by the appellant is, however, defective in not requiring the real value of the property and the fair value in themselves of the service rendered to be taken into consideration."

Mr. Justice Barnard, sitting in Equity Court No. 2, in the Supreme Court of the District of Columbia, delivered the opinion that "the companies furnishing the lower rates have generally been in business only a short time, and it is not clear from the evidence that they can make any profits at the rates charged, and at the same time keep up the plants in good condition. There are certain contingencies that must be anticipated. Depreciation of overhead plants and underground plants must be calculated upon and provided for. In overhead construction sleet and windstorms and large fires often do great damage. With a new company these things are not so carefully considered in making up statements as to the annual income and profits, experience being required to arrive at any certainty as to the business being profitable or otherwise."

Another official opinion of the propriety of including a proper charge for depreciation in estimating the value of telephone properties is found in the annual report of the State Board of Assessors of New Jersey. For this board, in "estimating the true value of average construction of telephone property in the public streets and highways" for the purposes of taxation, makes "an allowance of thirty-three and one-third per cent for depreciation." The "estimated value (allowing for depreciation) of telephone lines" is given as follows:

County lines, 1 mile overhead pole construction	$60
City lines, 1 mile overhead pole construction	200
One mile bare copper wire in place (each wire)	13
One mile lead-covered aerial cable in place (25 pairs)	545
One mile lead-covered aerial cable in place (50 pairs)	915
One mile lead-covered aerial cable in place (100 pairs)	1,650

The following tabulation of amounts annually expended in the construction of a certain telephone system, as presented in the sworn testimony given by the treasurer of a Bell licensee company, is an excellent illustration to show how close to the actual cost of depreciation an arbitrary charge of ten per cent per annum may come. The treasurer's testimony is as follows:

We commenced our construction in 1881, and we went on constructing and expending different amounts in different years until 1895. At the end of 1895 we had completed a new system, and to be sure that it agreed with what we had in our books on account of capital expenditure, we had it revalued, and the valuation came then to $648,232. We then took the amounts that had been spent year by year and took off ten per cent each year, and added the new construction; and the amount that it showed was, according to that, $701,707.62. These amounts are so nearly correct that it confirmed what we had previously arrived at generally and in other places—that ten per cent was the proper amount for depreciation of telephone plants for that time.

He further testified that this ten per cent "was in addition to the regular maintenance charge," and that

Constant changes are taking place in the telephone business. When a telephone exchange has grown to a certain extent the previous plant has to be got rid of and a new plant put up. A certain system of switchboards is not sufficient for the requirements of a larger

	Cost of Plant January 1.	Cost of Construction During Year.	Cost of Plant December 31.	Depreciation 10 Per Cent.
1881	.....	$40,900 00	$40,900 00	$4,090 00
1882	$36,810 00	12,455 57	49,265 57	4,926 56
1883	44,339 01	14,771 67	59,110 68	5,911 07
1884	53,199 61	21,756 91	74,956 52	7,495 65
1885	67,460 87	20,145 75	87,606 62	8,760 66
1886	78,845 96	49,109 70	127,955 66	12,795 57
1887	115,160 09	40,129 15	155,289 24	15,528 92
1888	139,760 92	33,863 98	173,624 30	17,362 43
1889	156,281 87	54,732 37	211,094 24	21,109 42
1890	189,984 82	81,158 21	271,143 03	27,114 30
1891	244,028 73	127,022 82	371,051 55	37,105 15
1892	333,946 40	176,831 46	510,777 86	51,077 79
1893	459,700 06	170,633 77	630,333 83	63,033 38
1894	567,300 45	146,283 76	713,539 21	71,353 92
1895	642,185 29	59,522 33	701,707 62	....

office. They have to be taken out and thrown away, and a new system introduced. These are things that can not be looked after year by year, but only at stated periods in the history of a telephone exchange when a complete change has to be made, and the money has to be provided to make the change. What you find in our regular payrolls for maintenance is simply general repairs to the system as it is then running. Beyond that, there is the new construction that has to be done for an entire change of system—small poles taken down and big poles put up in their places, and finally big poles taken down altogether and underground work put in; and that, in our experience between 1880 and 1895 required an annual setting aside of ten per cent.

He further testified that in his experience, after "having audited the accounts of banks, insurance companies and railways," he found "the financial transactions of telephone companies the most difficult of any . . . because of the constant change, and never ending of any one particular piece of plant. Every new subscriber is practically an increase to the construction account; and yet when you arrive at a certain stage you have to wipe a large portion of nearly all of it out, to replace it with something else."

If the experience of Bell telephone managers covering a period of twenty-five years clearly proves the existence of certain tangible conditions that tend to lessen in value the investment in telephone property, either directly through a reduced valuation or indirectly through a diminished earning power, are independents not doing themselves and the cause grave injury by not accepting Dr. Herr's statement as correct that full ten per cent must be allowed for depreciation each year? Moreover, if the business is honestly conducted and there is no intention of unloading undesirable property on inexperienced investors, how can there be anything "hurtful" in anticipating the different phases of depreciation and providing for the probable loss in some form of investment, insurance or depreciation allowance when determining what rates will yield a profitable return on the actual cash investment?

Studied from any honest point of view that includes safeguarding the actual investment and assuring to subscribers a modern high-class comprehensive and continuous service, there appears not only one but many phases of depreciation, all of which must be reckoned with. There are (1) depreciation from ordinary wear and tear in service and from breakage. (2) Depreciation from improvements in the art, rendering it economical to replace old with improved equipment, and to rebuild and make metallic all circuits. (3) Depreciation from excessive and unexpected growth, making necessary the entire rebuilding of circuits and the entire replacement of equipment. (4) Depreciation, due to lack of capital necessary to make extensions absolutely essential, if prestige is to be maintained. (5) Depreciation, due to unexpected and destructive effects of storms of wind, sleet and snow that no amount of engineering skill or of constructive ability can provide against, unless all lines are placed underground. (6) Depreciation from unavoidable friction with new and with old independent companies in neighboring towns, resulting in destructive rate-cutting, in absence of cooperation, and in delaying or preventing the united action that would lead to the adoption of a standardized method of construction and equipment of uniform rates and of an equitable interchange of toll service. As Dr. Bennett explained at the Des Moines convention, there are independents who "build up the man of straw, known as 'mutual' service, or who claim to worship their telephone deity by giving the public telephone service at less than cost, by throwing their time in as nothing and their money to suffer the consequence of the moth and rust." (7) Depreciation from the agitation of public ownership movements that tend to retard the normal healthy growth of the system through the withholding of contracts in anticipation of a lower rate or a more comprehensive service.

There are other phases, but let us first consider these seven.

The first phase to be considered is depreciation or a lessening in value through ordinary wear and tear in service and from ordinary breakage in service. This is a phase properly chargeable to current expenses through the maintenance account, the breakage or lessened life of the different parts appearing in the account as repairs, and is so treated by the Bell companies, and this maintenance account is an account separate and distinct from the accounts kept to care for other phases of depreciation. Let us see if men experienced in allied lines advise similar treatment.

Mr. George Wilkinson told the members of the Illinois Association of Public Accountants that—

The modern way is to write off a certain percentage of the value of the destructible plant each year, charging the amount against the earnings and crediting same to the asset account, thereby reducing it on the books, or, if preferred, crediting the amount to "replacement reserve account," thereby creating a liability, and leaving the assets intact. This method of charging a stated proportion of the cost of the plant against each year's earnings has one principal advantage. It distributes the cost of replacing the plant evenly over the life of the business, instead of allowing the entire cost of replacement to fall against the year or the two years in which such replacement has to be made. . . . All repairs and maintenance are charged against earnings as an expense; all additions and improvements are charged to plant account, and go to increase the investment, but all replacements and renewals may be charged to replacement reserve account.

The charge to be made against the earnings of a telephone company, with respect to depreciation upon its plant, should, in my opinion, be at the rate of ten per cent per annum on the average amount of plant in use throughout the year, based on the actual cost of construction. This charge for depreciation is separate and distinct from the charge for current repairs and maintenance, and is made to provide against the inevitable decay of the plant and the superannuation of the equipment.

Reviews of Current Engineering and Scientific Literature.

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Induction Motors.

In the discussion of Mr. Eborall's paper presented to the English Institution of Electrical Engineers, Mr. H. S. Meyer took issue in some of the opinions expressed as to the limited size of squirrel-cage motors. Mr. Alexander Rothert replies to the objections of Mr. Meyer as follows: While Americans are leading in long-distance transmission and size of machines, the design of polyphase machinery has been more carefully studied in Europe. The slip with squirrel-cage motors should not be less than six to seven per cent, otherwise the starting current will be excessive at any load. The influence of a squirrel-cage motor whose capacity is one-tenth of the generator output, when starting without compensator, will in most cases be equal to or worse than a full load of the generator with a power-factor of eight-tenths instantly switched on. Such is the influence on the generator alone, not to speak of the drop in the mains. Accordingly, in large stations a motor with one one-hundredth of the generator output could produce a drop of about two per cent in the generator, plus the considerable drop in the transformers, mains, etc. These figures show that squirrel-cage motors and lighting can not be fed by the same generators. With the exception of special cases, where slip rings are not permissible, there is no excuse for using squirrel-cage motors where rheostatic motors can be used, as the latter easily start at any load with little current and have a higher efficiency. In by far the most Continental lighting stations working on the three-phase system all motors of three horse-power and upward are required to be of the rheostatic type. Experience shows that most motors start with an overload, a smaller percentage against full load, and very few indeed with less than half load.—*Electrician* (London), July 11.

The Steam Turbine.

Mr. S. E. Fedden, city electrical engineer, has installed several large steam turbines in the Sheffield power station. These have an output of 1,500 kilowatts each, and with their condensers occupy only a space of 730 feet. Mr. Fedden, in a paper read before the Municipal Electrical Association, gives his reasons for selecting the steam turbine in place of the reciprocating engine. The turbine has been meeting with signal success in late years, and many engineers are now considering whether it is not destined to revolutionize the means of obtaining power from steam both by land and sea. The author suggests that inventors should turn their attention toward bringing to perfection gas turbines, these combining the ideal engine with the most economical way of obtaining energy from coal. The fundamental principle attending all methods of electrical work is implied by the word "velocity," a requirement eminently possessed by the dynamo, motor and rotary converter, but not possessed by the prime mover, the modern reciprocating engine. Attention was, therefore, directed toward increasing the speed of the engine, so as to adapt it for direct coupling with a high-speed dynamo. These efforts have been attended with success by the development of the high-speed steam turbine. Taking into consideration the large demands for electrical energy which must be met in the near future, it seems probable that the size of the generator and slow-speed engine would become unmanageable; also great difficulties would be experienced in shipping and erecting these. The aim of all engineers should be simplicity, and the modern reciprocating engine, with its numerous complications, can not by any means be considered the embodiment of this principle. Engineers laying down new plant have to consider the increased cost of building, the larger floor space required, the long lengths of steam and exhaust piping, valve-opening gears and heavy cranes for lifting, which are required in the case of large reciprocating engines, as against the simple requirements of a station laid out with steam turbines. The massive nature of the foundations, the time required for delivery and erection of large plants, are items which often seriously delay the speedy completion of contracts. From the year 1885 until 1890 nearly all the turbines manufactured were non-condensing and of small type. They were not economical; but great improvement both in construction and design has since been made in them. In the operation of the plant the priming or wet steam simply causes momentary slackening of speed until the turbine clears itself of water. Other advantages are as follows: The absolutely steady nature of turning movement; entire absence of cylinder lubrication, allowing all the condensed steam to be returned to the boilers. The time occupied in cleaning down is brought to a minimum, and is about one-sixth of that required in the reciprocating engine of a similar capacity. Superheated steam can be used to greatest advantage, and the cost for attention and repairs is small. In laying down a steam turbine plant the main factors to be considered are good vacuum in the condenser and arrangements for high superheat. From tests taken on the 1,250-kilowatt steam turbine sets now working at Elberfield, it was shown that there was a gain of twelve per cent with fifty-five degrees centigrade superheat, and that every inch of vacuum improves the steam consumption by four per cent. It is also shown that the steam consumption per horse-power in the turbines, other things being equal, decreases constantly with the increase of loads.—*Electrician* (London), July 18.

Electrically Driven Centrifugal Pumps in the Horcajo Mines, Spain.

The mines in question are situated in the mountains, five hours from the nearest railway station. With the exploitation of the mines, shafts had to be pushed deeper and deeper and trouble from water increased. At first various types of pumping engine had been tried without success. Finally a proposition was received from Messrs. Sulzer Brothers, of Winterthur, Switzerland, to effect the pumping by means of their new high-pressure centrifugal pumps coupled with electric motors. There was at this time an electric power plant at the mines. This proposal was accepted and the pumps installed according to the following scheme. They are arranged in sets of three, all being quadruple centrifugals. The lowest is placed at a depth of 388 metres and raises the water from the pumps below to the second pump which in turn

delivers it, still under pressure, to the third pump, no air entering the hydraulic system. The whole bulk of the water flows through all the pumps which consequently do the same duty at the same speed. Each of the pumps has to overcome a mean head of 129.3 metres, although they are not the same vertical distance apart. The pumps consist of a nickel-steel shaft, bearing four wheels, twenty inches in diameter, arranged in pairs on both sides of fixed discs. The discs are set in guide blades on either side. In the tests conducted at the Winterthur works, an efficiency of seventy-seven per cent was obtained. In the mines the pumps have a speed of 980 revolutions per minute and raise 925 gallons of water per minute to the height of 425 feet. The driving motors, built by Brown, Boveri & Company, of Baden, are of the short-circuited rotar-induction type. The pressure used is 1,000 volts and the constructors guaranteed an efficiency of ninety-four per cent, with a power-factor of 0.85, with a full load of 250 horse-power. The short-circuited armature has answered very well. Centrifugal pumps can start under zero torque which increases gradually. The motors are started with their pumps through an auto-transformer. The latter being switched in, the first motor is joined to the starting bar and takes from 200 to 240 amperes, but very rapidly gets up to synchronism. The connection is then changed, throwing the first motor to the main bus-bars, while the second is connected to the auto-transformer. In this way all three motors are brought up to speed. As the generator units are much weaker than the group of motors which work together, one engine is first run at a speed slightly below normal. The pumps will not be able to overcome the hydraulic pressure in the pipe system, and hence absorb only about thirty-five horse-power each. When the motors have all attained synchronism the engine speed is increased with the aid of the governor until the water delivery commences. There can be no doubt that this pumping system offers a remarkable adaptability to the peculiar difficulties in question, to keep a mine which is constantly being deepened free of water. The total efficiency of the centrifugal pump is not so high, but this is counterbalanced by the inherent advantages of this type of motor.—*Engineering* (London), July 18.

Electric Ropeways.

Switzerland, from its conformation, may be considered as the country of ropeways. Wherever a hill commands a good view or interferes with a road, a ropeway is constructed. The number of these is very great, but one of the most interesting is described by Mr. De Vevey in this article. This connects the village of Luzerne with the heights of the Gutsch. It is the most recent example of these installations and uses electric power for operating the cars. The length of the line is considerable, being 1,588 metres, with a difference in altitude of 416 metres. The grades vary from 13 to 34 per cent. One tunnel of 114 metres spans the road, the rest being in the open air. Many curves are rounded having a radius of 500 metres. The gauge is one metre and the weight of the rails 23 kilogrammes per metre. The tractive cable has a diameter of 31 millimetres. It weighs three and a quarter kilogrammes per metre and has a breaking strain of 134 kilogrammes per square millimetre. The rolling stock consists of two cars fixed to the extremities of the cable, the latter running on guides between the rails. It is driven by a 70-horse-power electric motor operating on continuous current. The generating station includes two belted thirty-horse-power generators, one being held in reserve. The prime-movers, which drive the generators, are gas engines supplied by a local generator. From the generating station the current is carried to a substation, installed at the upper terminus by a line of two conductors 600 metres long, with a cross-section of 75 square millimetres, and it is supported on poles and double-petticoat insulators. The substation contains a battery of accumulators composed of 114 pollak elements, with a capacity of 402 ampere-hours, at a rate of discharge of three hours or 276 ampere-hours per one-hour discharge. The normal rate of charge is 180 amperes. When the descending car is loaded and the mounting car empty, the driving motor operates as a generator and charges the accumulators. The battery supplements the electric generators during heavy load when the travel is great, but during stops between consecutive trips the generators charge the battery. Except during the morning and evening, when the difference in load is great, the batteries alone drive the motor and furnish lighting for all the stations. Each car weighs 5,200 kilogrammes empty and about 8,140 kilogrammes loaded. The average speed is 150 metres a second. The cars are furnished with automatic and hand-brakes. With an average of twenty trains per day, this roadway carries 13,000 passengers and 120 tons of merchandise per month. The financial results are excellent and the operation regular, without accident.—*L'Electricien* (Paris), July 12.

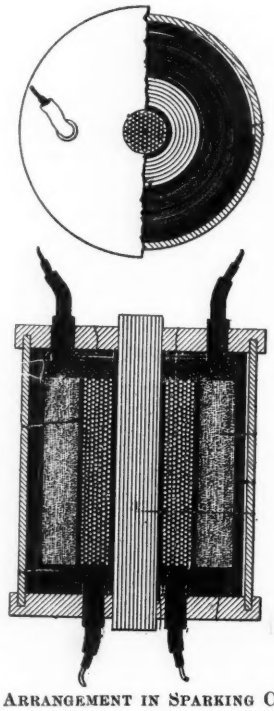
On the Effect of Low Temperature on the Recovery of Overstrained Iron and Steel.

It is well known that the recovery from overstrain is more rapid in the case of wrought iron than steel, but in either case the recovery is completed in a few moments by exposing the material to the temperature of boiling water. It appeared probable that the exposure of the overstrained bar to a low temperature might produce a retarding effect upon recovery. The behavior of overstrained metal under low temperatures is not only interesting from a purely physical point of view, but is of importance in practical applications. Experience has shown that iron and steel exhibit the same tendency to recover their elasticity with time, whether the strain be tension, compression, shear or bending. As tension experiments are more easily carried out, this method was adopted by Mr. E. G. Coker in this investigation. Annealed bars were taken from a piece of steel boiler-plate and stretched beyond the yield-point in the usual way. Immediately after the condition of each bar was examined by resetting the extensometer and subjecting the material to a cycle of strain and the results recorded. If a bar overstrained in this way be allowed to rest in a room of ordinary temperature, it will begin to recover at first very rapidly, but after a lapse of time, more slowly, regaining its primitive elastic condition in three or four hours, provided the permanent extension is not more than two or three per cent. As a means of comparison, previous experiments were made on a bar cut from the same plate. This showed complete recovery in four hours and was characteristic of the material under the conditions. The effect of temperature was then determined. The bar was first strained beyond the recovery-point and the recovery-loop determined immediately afterward. It is then exposed for about six weeks to a temperature below freezing and the recovery-curve again determined. This showed that there was no recovery during that time, and that a temperature below that of melting ice caused a complete arrest of recovery. The same experiment was conducted on wrought-iron bars. As is known, iron recovers from overstrain at a comparatively rapid rate, as compared with steel. The conditions of experiment were nearly the same. The bar showed a decided recovery during the first six weeks, but at this point no further change took place. The explanation given for this is that beyond a certain point the action of the low temperature is insufficient to maintain conditions of overstrain which, therefore, gradually diminish until the point is reached at which the tendency to recover is balanced by the opposing action of temperature. In the case of steel the tendency to recover from overstrain is entirely balanced by the opposing effect of temperature, and its recovery is in consequence entirely arrested.—*Physical Review*, August.

Electrical Patents

A thermoelectric element having distinct advantages has been invented by Mr. Charles B. Thwing, of Galesburg, Ill., who has sold his entire interest to Louis S. Langville, of New York city. It is well known that the electro-motive force generated by the unequal heating of the junction of a thermoelectric pair is very small, and it has been sought to find such alloys of metals as would make this electromotive force as large as possible. The inventor has adopted for the positive element a metal as refractory as the nickel alloys commonly used for the negative element and has sought to increase the electromotive force by finding suitable alloys of nickel for the negative element. Thus if iron be used for the positive element it will give with a suitable negative element an electromotive force about one-half as high as that obtained from antimony and zinc alloy, while it is stated at the same time possessing such superior conductivity and strength that four such elements occupy no more space than one of the antimony-zinc elements having an equal resistance, while the strength is much greater. Another feature of importance resides in the fact that the high melting-point of the metals used makes it possible to braze the joints together, thus enabling them to be heated to a red heat in use without in the slightest degree impairing either the mechanical strength or the electrical conductivity of the junction. For the positive element there is employed iron or any alloy in which iron predominates. For the negative element there is used an alloy of nickel and copper of the chemical composition Ni_3Cu_2 having the proportions, by weight, of 1,746 parts nickel to 1,264 parts copper. It will, of course, be understood that these exact proportions may be deviated from to some extent without greatly impairing the electrical qualities of the alloy. This alloy is very strong, ductile and practically non-oxidizable. The pair may be assembled in any preferred form, the nature of the materials used being such as to readily adapt them to use in any desired situation. The elements may be cast one upon the other or joined by brazing or other hard soldering. An alloy of copper and antimony in the proportions of nine of copper to one of antimony, which has a melting-point slightly below that of copper, may be employed for the solder, or copper itself may be used therefor, since its melting-point is lower than that of either of the metals used for the elements. The higher the melting-point of the solder the higher the temperature that may be employed in the operation of the generator.

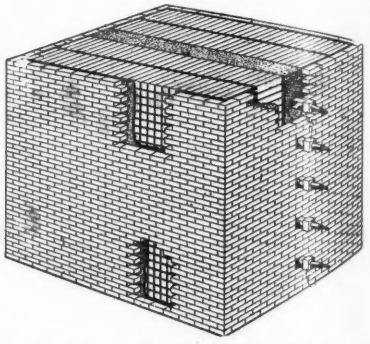
An improvement in sparking coils has just been patented by Mr. Charles F. Splitdorf, of New York city, the object



NEW ARRANGEMENT IN SPARKING COILS.

being to provide an improved casing for coils of the jump-spark type to render the same strong and durable, impervious to moisture, and having the quality of non-conductiveness to such an extent as to prevent leakage of the electric current therefrom. To these ends the casing comprises an outer cylindrical shell composed of fibre or other infrangible substance possessing to some extent the quality of resisting the passage of an electric current. Within the shell is arranged a cylindrical roll of thin sheet rubber, either hard or soft, that is wrapped upon itself to form a plurality of thicknesses. Outer end discs, also of fibre or the like, close the ends of the casing, and thin sheets of rubber are interposed between the discs and the ends of the coil.

Charles M. Hall, of Niagara Falls, N. Y., has originated a new method of baking carbon electrodes. Such electrodes, especially those used in fused electrolytic baths, require to have good conductivity, mechanical strength and toughness, combined with a high ignition-point. It has been common for the purpose of imparting these qualities to place the electrodes, after they have been moulded and compressed, in gas or coal furnaces, where they are baked for a prolonged time. Mr. Hall provides means whereby electrodes in large quantities can be baked by electrical heat, and raised thereby to a temperature higher than that ordinarily obtained in gas furnaces. The present invention consists in piling the electrodes to be heated around or adjacent to a conducting core or path of suitable resistance, through which the current passes, and insulating the electrodes, so that the main heating current shall be confined to the core without passing in large volume through the electrodes. The insulation accomplishes important functions. First, by restricting the current to the core, the latter is proportioned so that it will have sufficient electrical resistance to develop the required heat without the use of current of excessive volume, whereas if the electrodes themselves constituted the current path the resistance would be irregular, and during the operation would become so low on account of the elevated temperature and



NEW METHOD OF BAKING CARBON ELECTRODES.

loss of volatile matter and consequent increase in conductivity of the electrodes that the furnace would be impossible to regulate if the quantity of electrodes under treatment were large; second, the insulating of the electrodes by localizing the current within the core renders the transmission of heat to the electrodes gradual, and thus yields a better product. The electrodes may be insulated by interposing between the individual electrodes or groups thereof a refractory non-conducting material—such as bauxite, purified alumina, magnesia or lime alone or mixed with fine carbon—and the electrodes are arranged in a pile or piles around or at the sides of a conducting core of carbon, either in a horizontal or a vertical furnace.

The application of the Allegemeine Elektricitäts Gesellschaft to the German patent office for the annulment of the Braun wireless telegraphy patent has been refused with costs.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Water-Wheel Governors.

The necessity of effectually controlling the speed of water-power plants has become a matter of the first importance, for it presents a difficulty which is not easily overcome. In electrical work this necessity has been emphasized of late years by the extending use of alternating-current high-voltage systems in place of the older direct-current low-voltage systems, for the former brings with it new classes of subsidiary apparatus such as converters, synchronous motors, etc., which require a very steady speed for their successful operation. The demand for steady and reliable service becomes, also, more imperative as the service extends and consumers multiply, and it is a truth recognized by leading business men connected with these enterprises that no pains or expense should be spared to secure this end.

In a water-power plant representing a large investment it is obvious that its efficiency as a revenue earner should not be diminished by omitting such an important item as its effective speed regulation. In the case of an electric station such an omission is likely to result in considerable loss, not only by reducing patronage through faulty service, but by affording opportunity for accident and shut-downs and consequent heavy repair expense.

The governor which is illustrated in the accompanying engravings represents much experience in water-wheel control, gained while conducting extensive experiments at a number of water-power plants operating under widely differing conditions in various parts of the eastern states.

The requirements which a governor must satisfy, and the principles on which the speed regulation of water-power plants depend, have been strictly borne in mind when determining not only the general designs, but the smallest details of the governor, and the maker claims it to be constructed in accordance with the best and most modern engineering practice.

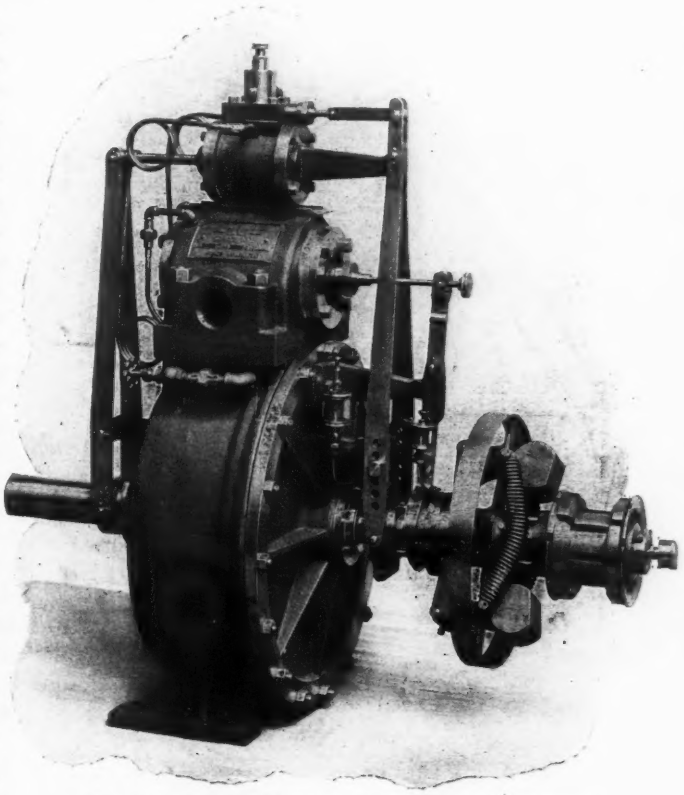


FIG. 1.—EXTERIOR VIEW OF WATER-WHEEL GOVERNOR.

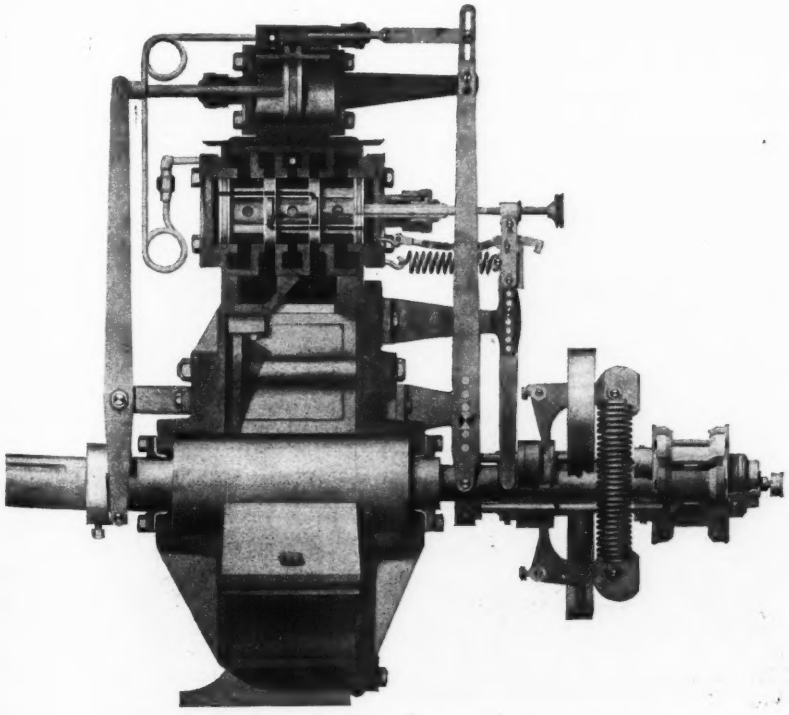


FIG. 2.—SECTIONAL VIEW OF WATER-WHEEL GOVERNOR.

Fig. 1 shows an exterior, and Fig. 2 a sectional view of the governor. It is of the hydraulic type, the water-wheel gate being actuated by hydraulic pressure. In the system used, however, the governor, pump and receiver are not incorporated in one machine, but are distinct and may be combined in any way which may be most economical or satisfactory for the particular plant in which it is to be installed. Thus, the receiver may be placed either beneath the governor, or in a corner, or in a cellar beneath the power-house, well out of the way, while the pump may be bolted to the base on which the governor rests, or fixed on the side of the governor when this is carried on a bracket and has no base, or it may be placed independent of the governor in any adjacent part of the power-house.

The hydraulic cylinder of this governor

gives a direct rotary motion, without using any racks, pinions and other gears, and when possible it is coupled direct to the gate-shaft, making a short, rigid connection. This may be done when the gate-shaft makes approximately one revolution to open the gate (between 0.75 and 0.90, to be exact). If the gate-shaft makes more or less turns than this, a single pair of gears only is required to produce the correct ratio.

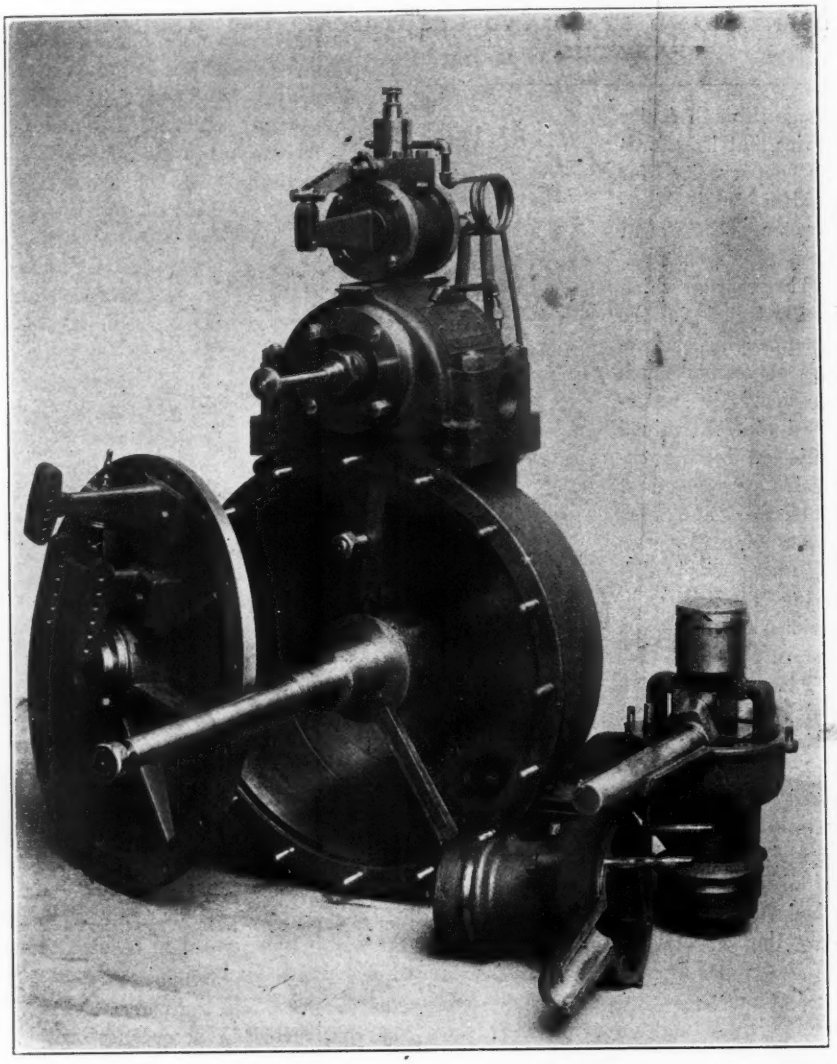


FIG. 3.—WATER-WHEEL GOVERNOR, WITH COVER REMOVED.

The pump has been specially designed for this work, and is made very massive and readily accessible. The governor consists of a cylinder, a valve to admit fluid to the cylinder, a centrifugal governor to operate the valve, and a relay to determine the amount the gate shall move and to prevent racing.

This cylinder is shallow and of large diameter, with one end cast solid and the other removable. It is provided with two very large bearings which receive a heavy shaft, one end of which projects at the back and has a key-way for coupling to the gate-shaft, and the other projects in front, and is reduced to receive the centrifugal governor. The shaft is provided with a radial square piston, which is fitted with metallic packing that makes a fluid-tight joint on the walls of the cylinder. A partition is fixed rigidly in place, and makes a fluid-tight joint against the walls of the cylinder and the boss of the piston, and completes the arrangement by which the piston is moved by fluid introduced on one side or other of the partition.

A five-ported valve chamber is bolted to the cylinder, the centre port being the inlet, the two middle ports the cylinder ports, and the two outer ones the exhaust ports, which have a common outlet opposite the inlet.

The valve is of large diameter, in order to give quick gate movements, but it is not moved directly by the centrifugal governor, as this would be impracticable. It is moved by hydraulic pressure by an arrangement clearly shown in the sectional view. This valve is provided with two piston extensions which work in an extension of the valve bore, and has a small inner valve which is easily controlled by the governor. This valve admits the fluid from the main inlet through ports leading to the piston extensions, and thus causes the main valve to reproduce the exact movements of the small valve. This is a very simple and effective way of securing this result, and constitutes one of the essential patented features of the governor.

The centrifugal governor is of a special type. It is specially designed to give a powful working factor, a wide range of movement and great delicacy. The weights act directly on a sleeve which does not rotate with the governor, and therefore an almost frictionless sliding movement is obtained. The movement of the sleeve

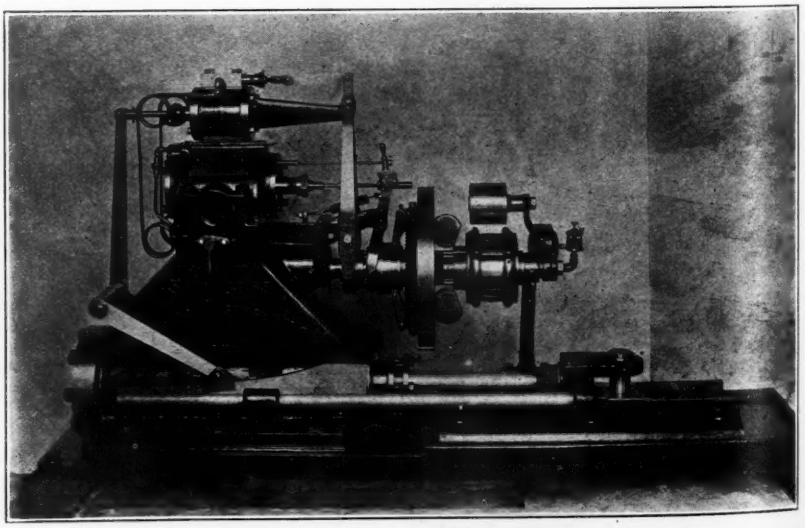


FIG. 4.—WATER-WHEEL GOVERNOR, SPECIALLY DESIGNED FOR YORK-HAVEN POWER COMPANY, SUSQUEHANNA RIVER.

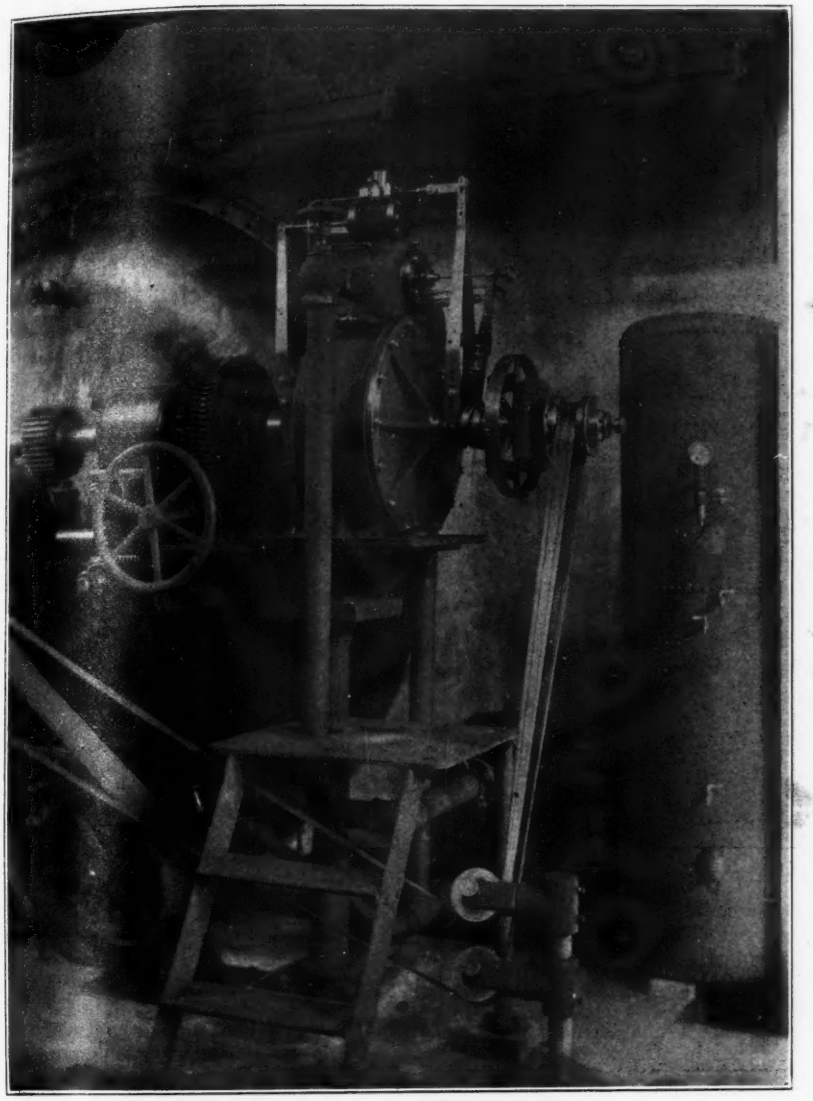


FIG. 5.—A TYPICAL GOVERNOR INSTALLATION, VIRGINIA ELECTRIC RAILWAY AND DEVELOPMENT COMPANY, RICHMOND, VA.

is communicated to the valve by an adjustable lever, the top of which is provided with a latch which automatically disengages, and causes the gate to close if any accident happens to the governor or the belt. The whole governor rotates on the reduced extension of the main shaft, lubrication being effected by a grease-cup and a hole bored up the centre of the shaft. It is driven by a special segmental pulley, or relay, double two-inch belt being used to run the governor.

The relay is for causing the governor to move the gate the correct amount required and prevent racing, this being accomplished by restoring the centrifugal governor to its normal speed somewhat in advance of the water-wheel, and thereby counteracting the "lag" of the latter. It consists of a cam upon the main shaft, two pairs of levers connected at their upper ends by a small hydraulic cylinder which performs the functions of a dashpot, only with more reliability, and a special segmental driving pulley on the governor. This pulley consists of two cones, one fixed and the other movable, between these cones being a number of segments which slide in recesses in the cones. The movable cone is connected by two rods to a collar attached to the lower end of the front levers, the movement of which levers is therefore communicated to the cone and causes a slight expansion or contraction in the diameter of the pulley. This slightly varies the ratio between the speed of the water-wheel and the centrifugal governor at the proper time, and causes the latter to assume its normal speed in advance of the water-wheel, and so closes the valve and arrests the movement of the gate when it has moved far enough.

The small cylinder is displaced endwise by the movement of the lever, sliding in a channel in the valve chamber, and this movement opens a slide valve on its upper side, attached by links to the front levers, and admits fluid from the main supply, through coiled copper tubes, to the cylinder, and causes it to slowly recede to its original position. This restores the pulley to its original diameter and leaves the speed of the water-wheel exactly as it was before.

These movements are all positive, and do not depend upon springs or trip devices, and there is little chance for wear or derangement.

Fig. 3 shows the governor with the cover removed, and Fig. 4 shows a modification of the governor specially designed for the York-Haven Power Company, on the Susquehanna River. Fig. 5 shows a typical governor installation at the plant of the Virginia Electric Railway and Development Company, Richmond, Va. Fig. 6 shows a large view of the expansible pulley.

This governor is manufactured by the Sturgess Governor Engineering Company, of West Troy, N. Y. It has met with complete success in a number of notable installations and many important plants are to be thus equipped during the present year.

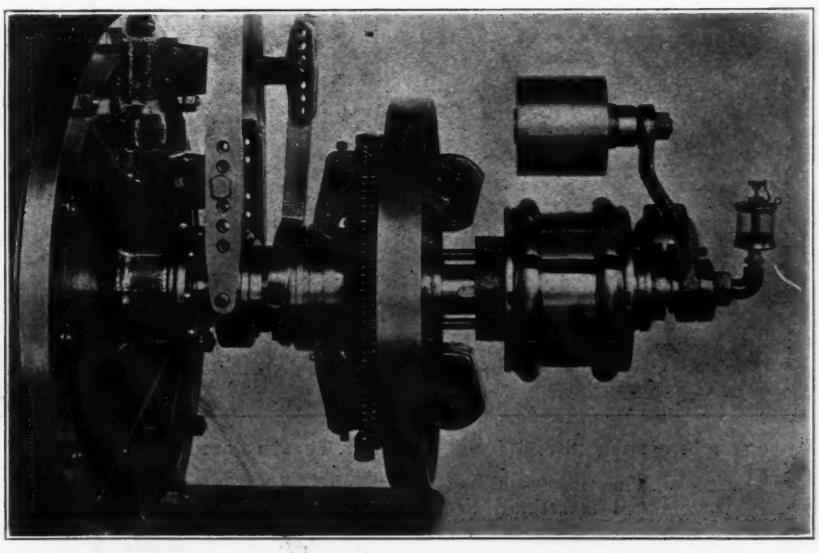


FIG. 6.—WATER-WHEEL GOVERNOR, SHOWING LARGE VIEW OF EXPANSIBLE PULLEY.

A New High-Tension Insulator

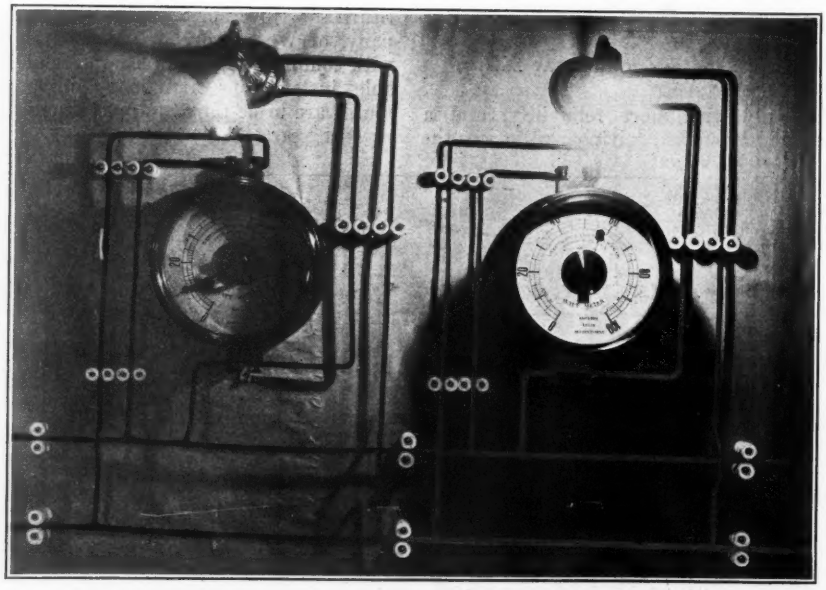
In the accompanying illustration is shown a new high-tension insulator for 80,000 volts. It is stated that this insulator will carry successfully 100,000 volts, and has been tested to 100,000 volts in a heavy rain-storm. The insulator is fourteen inches in diameter and is twelve inches high and is designed for and will be in use in the Bay County, Cal., transmission lines and several other lines for heavy service. The insulator weighs eighteen pounds and is claimed by the manufacturer, Fred M. Locke, of Victor, N. Y., to be mechanically and electrically the best that has yet been produced.

HIGH-TENSION INSULATOR FOR 80,000 VOLTS.

Wattmeter Readings.

In the accompanying illustration is an interesting comparison of the current consumption of two different sizes of filaments burning on the same circuit. This is a photograph of an actual test, and it shows the smaller filament registering about ten watts at one candle-power. The larger filament registers about fifty-seven watts at sixteen candle-power.

The lamps used in this test were the "Hylo" lamps, manufactured by the Phelps Company, of Detroit, Mich. The "Hylo" lamp is turned down from a bright light to a dim light by slightly unscrewing the lamp in the socket.



WATTMETERS LIGHTED BY "HYLO" LAMPS. ON LEFT, TURNED DOWN, ON RIGHT, TURNED UP.

The Proposed Change of Equipment on the New York Central Railroad.

Announcement has been made that the New York Central & Hudson River Railroad Company intends within two years to have in operation one of the greatest electric traction systems of the world, at an expense of some $10,500,000, and an additional cost of $4,000,000 for changes to be made in the yards from Forty-ninth street to Fifty-sixth street, along Park avenue, in New York city. It proposes the abolishment of steam as a motive power on its lines within a distance of thirty miles from New York, and the probable erection of a great three-deck passenger station above the Harlem River for the sole use of its suburban traffic. Mr. W. C. Brown, third vice-president of the railroad company, is credited with the statement that the company is proceeding on the basis that the necessary legislation may be had, and that the work will be pushed rapidly forward to completion. It is proposed to so move the west roadway that an open cut sufficient to maintain two additional main tracks and one storage or switching track will be secured. Six tracks will then be made available for train service. Through trains will be hauled by electric motors to Croton Landing, on the main line, and to White Plains, on the Harlem division, and with a delay of not more than a minute change will be made to steam locomotives. On suburban trains the motors will be attached directly to the cars by the multiple-unit system, along the lines recently laid down by Mr. Bion J. Arnold.

Power stations will be built and machinery installed to generate 100,000 horse-power, which will be necessary to maintain the train service. Two or three such plants will be located at favorable points along the lines of the road. The third-rail system will be used to convey the electrical energy, and only in a few instances in the yards will it be necessary to install an overhead system. Steam will be abolished everywhere about the yards; even the switching will be done by electrical power. The tunnel will be lighted by electricity and all stations within the radius of electric traction.

The Rapid Transit Subway Construction Company, New York, has just placed an order for three 1,250-kilowatt turbo-generator sets for installation in its new power-house, and also two 400-horse-power Westinghouse vertical marine-type, cross-compound engines. The turbines will be used for lighting the power station, subway and stations, and the compound engines, which are built to run on high-pressure, superheated steam, direct-connected to Westinghouse generators, will be used as the main exciter units for the power station.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

ELECTRICAL SUPPLIES FOR INDIA—The Calcutta Electric Supply Corporation, Limited, which operates in Calcutta, India, has determined to place contracts for a large quantity of material for extensions of the plant for additional mains and feeders. The capital of the company is to be increased by $1,500,000, making the total capitalization $8,000,000.

SPANISH ELECTRIC TRACTION SYSTEM—The Malaga Suburban Railways, Limited, has been organized for the purpose of building an electric traction system through the Spanish province of Malaga. The total length of the road will be about 120 miles and will connect the city of Malaga with twenty-five towns and villages, having a population of nearly 500,000, including Malaga. Two waterfalls on the route have been secured, and if the power developed at them is not sufficient they will be supplemented with steam power. The company is capitalized at $2,500,000. The directors are Sir Richard J. Cartwright, Canadian Minister of Commerce; Peter Ryan, Registrar of the city of Toronto; J. Enoch Thompson, Spanish Consul at Ontario, and Ernest L. Sawyer, of Toronto and Paris. The major portion of the necessary equipment will be purchased in the United States.

BIG DEAL IN SIOUX CITY—One of the biggest financial deals in the history of Sioux City, Iowa, has been closed by the purchase of the Sioux City Traction Company, which owns all the street car lines in Sioux City, forty-three miles, and the Sioux City Gas and Electric Company, by the interests which control the Sioux City stock yards. The companies will be merged. The exact sum involved is not known. The traction company is capitalized at $1,500,000. Neither company has a rival in the field. The negotiations for the purchase were conducted by Colonel I. C. Elston, of Crawfordsville, Ind., who has large financial interests in Sioux City. The deal was closed by Colonel I. C. Elston, of Crawfordsville, Ind., president of the Sioux City Stock Yards Company, when he gave his check for $80,000 to bind the bargain. The traction company has forty-nine miles of railway and is capitalized at $1,200,000.

NEW ELECTRIC LIGHT INCORPORATION—The Edison Electric Company has filed articles of incorporation in Cheyenne, Wyo. The company is composed of Chicago and San Francisco members of the Wells-Fargo Express Company, and the concern is capitalized at $10,000,000, $6,000,000 of which is preferred stock and $4,000,000 common. The company proposes to establish a power and light plant somewhere in the vicinity of Evanston, in the northwestern part of the state, and in the Unitah oil fields, and furnish light and power to the scores of towns that are expected to spring into existence as a result of the predicted oil boom there. The company will also build and operate electric railways, furnish power to run drills and pumps in the oil fields, and also transmit power to distant mining camps such as Park City, Utah, and possibly to Ogden and Salt Lake City. The concern will also operate lumber mills in the mountains and prepare material for building when the boom strikes the oil fields.

NEW ALABAMA TRACTION COMPANY—The incorporation papers of the Montgomery (Ala.) Traction Company, the new street railway company which is building the line to Pickett Springs, and which is to build lines on various streets in Montgomery, have been filed in the office of Probate Judge, J. B. Gaston. The incorporators of the new enterprise are Barrie L. Holt, W. H. Ragland, W. F. Vandiver, Edward A. Graham and W. T. Robertson. The company, the declaration of incorporation states, is capitalized at $1,000,000, divided into 10,000 shares with a par value of $100. The incorporation papers give all the streets and roads upon which the company proposes to build its lines. Accompanying the declaration are the franchises granted the company by the city council of Montgomery, the board of revenue of Montgomery County, and the town council of Pickett Springs. The papers declare the intentions of the company to operate a street car system by electricity or steam, to purchase, lease and improve real estate and it has the power to borrow money when necessary. The place of business of the company will be Montgomery.

IMPORTS AND EXPORTS FOR JUNE—The June report of the Treasury Bureau of Statistics, showing the imports and exports by articles for the month of June and for the entire year compared with preceding years, has just been completed. It shows that the total exports of manufactures are $403,890,763, against $412,155,066 in 1901, a reduction of $8,264,303. In iron and steel manufactures alone the exports have fallen from $117,319,320 in 1901 to $98,552,562, a reduction of $18,766,758. Thus the decrease in iron and steel manufactures alone is ten million dollars greater than the total reduction in exports of manufactures, indicating that in other articles there has been a net increase. Taking the general class of manufactures exported, it may be said that a majority shows an increase in 1902 compared with 1901, while some of the articles showing a decrease in value of exports show an increase in quantity, indicating that the reduction is due in some cases to reduced prices and not to reduced exports. In copper, for example, the exportation of ingots, bars, plates, etc., amounted in the fiscal year 1902 to 288,720,655 pounds, against 252,769,328 pounds in the preceding year, an increase of 35,951,329 pounds; while the value was in 1902, $39,190,619, against $41,260,376 in 1901, a reduction of $2,069,757.

ELECTRIC LIGHTING

LIVINGSTON, MONT.—At the regular monthly meeting of the city council, Mr. E. Goughnour asked for a permit to erect poles on the streets and install an electric light plant.

BOWLING GREEN, OHIO—The interests of the Citizens' Heat, Light and Power Company and those of the Lake Erie, Bowling Green & Napoleon Railroad Company were consolidated recently.

SAN BERNARDINO, CAL.—The Mentone Power Company has saved its franchise, which a rival corporation had attempted to forfeit, by setting up poles inside the city limits, and construction work will be commenced in the near future.

NORTH TONAWANDA, N. Y.—The committee on street lighting of the board of aldermen, has prepared specifications for lighting the streets for one year from August 1, 1902, and the contract will be awarded in the beginning of that month.

COLUMBUS, OHIO—The plans and specifications for the new electric light plant have been completed and the board of public works will soon advertise for bids. The plant will provide for 1,500 arc lights and is to cost about $200,000.

PITTSTON CITY, PA.—The Citizens' Illuminating and Electric Light Company is building a retaining wall for the protection of its plant, as it has been discovered that the property of the company was in danger from the ravages of floods.

ST. JOSEPH, MO.—The property of the St. Joseph Railway, Light, Heat and Power Company was recently sold by E. H. Harriman, of New York, to Seligman & Company and E. W. Clark & Company. The company is bonded for $3,500,000.

COFFEYVILLE, KAN.—A final settlement has been effected between the village council and the St. Louis Electrical Supply Company, whereby the company was allowed $2,000, and a receipted bill for the balance of the indebtedness in the building of the electric light plant.

TRENTON, N. J.—A petition is being circulated by the citizens of Trenton, asking the village council to order a special election at which a vote will be taken on the advisability of bonding the village for the erection of an electric lighting plant to cost about $5,000.

NORTH YAKIMA, WASH.—The growth of the city has led the Yakima Light and Power Company to increase the capacity of its plant to about double its present power. A fifty-foot addition is to be built, containing new pumps, horizontal turbines and a 500-horse-power three-phase electric generator.

SALT LAKE CITY, UTAH—A contract is held by Flick & Johnson, contractors, for the installation of an electric lighting system at Stockton Bar. As the terms of the

contract require that the line shall be completed by January 1, 1903, work will be carried on day and night. An electric plant is being erected at the scene of operations for the purpose of furnishing light for grading.

GRAND RAPIDS, MICH.—Mr. J. G. Robertson, of St. Paul, has been awarded the contract for the erection of an electric light plant in the village at a cost of $24,500. The specifications call for two engines of 125 horse-power each of the tandem-compound condensing type, which are to be built by A. L. Ide & Sons, Springfield, Ill.

JACKSONVILLE, FLA.—The fight for the extension of the city electric light plant is now in progress and the decision of Judge Call is awaited with much interest. In connection with the argument Mr. B. F. Dillon, chairman of the board of bond trustees, presented an affidavit showing that the city plant is a highly profitable investment, the earnings aggregating more than $5,000 per month, and that with an expenditure of $42,000, the plant will be put in condition to meet the heavy demands upon it. The increased consumption of electricity in the city would seem to justify the use of the profits in the work of extension.

TELEPHONE AND TELEGRAPH

SAYVILLE, L. I.—The Wireless Telegraph Company has contracted with the Long-Distance Telephone Company for the construction of an independent telephone wire along the latter's line from New York to the wireless telegraph station at Sagaponack.

DES MOINES, IOWA—The Mitchellville Telephone Company filed articles of incorporation with the county recorder. The capital stock is $10,000, divided into shares of 100 each. J. B. Uhl, B. R. Patterson and S. J. Oldfield are the incorporators. All are of Mitchellville.

MILWAUKEE, WIS.—The Wisconsin Telephone Company is preparing plans for the erection of two branch exchange buildings in Milwaukee, besides making other improvements to the system in the city proper, and also putting in 1,000 miles of additional circuits throughout the state during the present year at an outlay of $500,000.

SAVANNAH, GA.—Mr. J. W. Crews, superintendent of the fifth district of the Southern Bell Telephone and Telegraph Company, with headquarters at Savannah, has been promoted to the position of assistant general manager of the company, with headquarters at the company's general offices in Atlanta. The change has already taken place.

SIOUX CITY, IOWA—A representative of the Stromberg-Carlson Telephone Company, of Chicago, has been in Sioux City and made enquiries as to the holding of a special election for the securing of a franchise for a new telephone exchange which his company proposes to put in here. The probabilities are that on his report being made the company will ask to have a special election held. It is stated that the company will expend $250,000 in putting in an underground system if given a franchise.

MATTOON, ILL.—Six of the largest telephone companies in Edgar and Clark counties have merged their plants into one concern, known as the Wabash Valley Telephone Company. The plants in the syndicate are located at Chrisman, Metcalfe, Paris, Vermillion, Marshall and West Union, and the capital stock has been increased from $30,000 to $125,000. The officers of the new company are: President, H. H. Knipe, of Marshall; secretary, A. L. Keyes, Marshall; treasurer, James A. Earhart, Chrisman; directors, George A. Fair, Charles Fair, A. K. Hartly, of Chrisman; A. L. Keyes and H. H. Knipe, of Marshall. The merger controls 1,700 telephones, and bonds for its consummation are already sold.

WIRELESS SERVICE PROMISED—The current daily press of London has announced that a company has been formed with a nominal capital of £175,000,which has been privately subscribed, for the purpose of operating the Armstrong-Orling system of wireless telegraphy. The *Westminster Gazette* says it is informed that this company will begin operations on a large scale almost immediately. Two factories will be erected in Buckinghamshire, England, and in France at places which have already been selected. According to advance proofs of the price list, it is said that the charge for each transmitter for sending Morse signals short distances will be £10 and for long distances £15, in addition to a royalty of £1 per year. A complete telegraph outfit for short distances will cost £4 per year and a royalty of £1.

ELECTRIC RAILWAYS

CALUMET, MICH.—The Houghton County Street Railway Company has been granted a franchise to build and operate a street railway in the township of Calumet.

SCHENECTADY, N. Y.—The Schenectady Railway Company has begun work on the Schenectady-Ballston road, at the Ballston end of the line, with a large force of men.

PHILADELPHIA, PA.—It is stated that a new company, known as the Pleasantville & Atlantic City Trolley Company, will build an electric road from Philadelphia to Atlantic City. Work will begin at once.

BUFFALO, N. Y.—A new company, known as the Buffalo, Rochester & Niagara Falls Railroad Company, will build an electric line to Hornellsville by way of Niagara Falls and Rochester. The capital invested is mostly New York money.

MEYERSDALE, PA.—A party of New York capitalists, representing the Metropolitan Trust Company, of that city, recently went over the route of the proposed trolley line to connect Meyersdale and Salisbury. The bids for the construction of the road have already been advertised.

GENEVA, OHIO—The village council has passed an ordinance granting the Cleveland, Painesville & Ashtabula Railway a twenty-five-year franchise to operate a railroad passing through the village on East and West Main streets. The power-house is to be erected at Geneva and the railroad is to be completed by July, 1903.

COLUMBUS, OHIO—The Canton-New Philadelphia Railway Company, of Canton, was incorporated recently with $600,000 capital stock by Edward C. Louis, Jeremiah E. Reeves, John C. Welty, Philip L. Saltonstall and Lewis E. Myers. They will construct and operate an electric railway from Navarre to New Philadelphia.

JANESVILLE, WIS.—Work on the Beloit, Delavan Lake & Janesville interurban line is being rushed between this city and Beloit. Several crews are at work finishing up the grading and the laying of the ties and rails will soon be commenced. The line from Beloit to Rockford is practically completed, and the trolley wires are about all in place.

LYDONVILLE, VT.—A project is on foot to build an electric railway from Wells River to Groton. This road would give direct connection with the B. & M., and the two would work in harmony. The enterprise would be of great value in developing the business of the valley and furnishing cheap freight and passenger tariffs.

RICHMOND, VA.—The merging of the street railway and electric power properties of Richmond into one ownership and control, that of the Virginia Passenger and Power Company, has been completed. The Traction and Passenger and Power Company will continue for a time to operate, as at present. There is a report that Mr. Cowardin will continue as superintendent of the traction lines. It is probable that a new scheme of operating the routes and cars of the two companies will be worked out in a short time.

NORWICH, CT.—Construction of the electric railway between Danielson and Wauregan is being pushed rapidly. The road will be completed in about two months to Wauregan, and then the company will push the construction to Central Village and Moosup, so as to reach the latter place this season, and ultimately Norwich. The road from Worcester to Norwich has five connected systems in operation or building: Worcester & Webster, Webster & Dudley, Thompson Tramway, People's Tramway, and Danielson & Norwich Street Railway Company.

DENVER, COLO.—Ground has been broken for the erection of a $400,000 addition to the Tramway power-house on Platte street. The addition is to be built at the north end of the immense power-house which has just been completed, and will be larger than the first building. The purpose is to more than double the power obtained from the present plant, so that the Tramway company may abandon completely the present power stations scattered about the city. In connection with the construction of the power-house it has been announced that the Denver & Northwestern Company will advertise for bids for grading the line fourteen miles further, to run it into the mountains as far as Copperdale, beyond Layden.

ELECTRICAL SECURITIES

There was a slight decline in the market for the week ending August 2. Yet although the average declined a number of railway stocks were strong.

Manhattan Railway, New York, was strong on reports of negotiations looking to its control by the New York Central Railroad. It is gratifying to note that the financial outlook in general still makes for actual stability in the market, even if it is far from warranting what Wall Street fondly designates as speculative buoyancy. The returns of the mercantile agencies, as well as the compilations of the financial journals, and finally the statements of railway traffic, all go to show that the industry of the country at large is not only being firmly maintained on the high levels of the year, but is expanding further. The losses incidental to the strike of the anthracite coal miners, while severe, are localized, and in fact it is a subject at least open to question as to what extent the original producers and sellers of anthracite coal are sufferers from the existing situation.

An important local development is thus described by a financial writer in the New York *Sun*:

"The final organization of the United States Realty concern has been completed, and while this particular form of enterprise has long since passed out of the experimental stage, it is still true that investors have offered to them a somewhat novel means of employing their resources. Persons of moderate capital now have the opportunity of participating in the development of New York real property which has long been a field available only to individuals of great wealth. The virtual rebuilding of this borough, now so strikingly in progress, is a spectacle available to every one passing through the city's streets and avenues. Not indeed since the organization of the United States Steel Corporation, with which the United States Realty Company is closely associated, has there been presented for consideration a more interesting and important development in the industrial and financial field."

ELECTRICAL SECURITIES FOR WEEK ENDING AUGUST 2.

New York:	Closing.
Brooklyn R. T.	69¼
Con. Gas	222½
Gen. Elec.	185¼
Kings Co. Elec.	203
Man. El.	136¼
Met. St. Ry.	149¾
N. Y. & N. J. Tel. Co.	176
Westinghouse Mfg. Co.	214

Chicago:	Closing.
Chicago Edison Light	176
Chicago Telep.	165
Metropolitan El. pf.	90
National Carbon	30
National Carbon pf.	162
Union Traction	16
Union Traction pf.	51

Boston:	Closing.
Am. Telep. & Tel.	164½
Edison Elec.	280
Mass. Elec. pf.	97½
New England Tel.	145
Western Telephone & Telegraph.	102

Philadelphia:	Closing
Elec. Co. of America	9
Elec. Stor. Bat. c	90
Elec. Stor. Bat. pf.	89
Philadelphia Elec.	5¾
Union Traction	46¾
United G. I. Co.	109

NEW INCORPORATIONS

COLFAX, IND.—People's Co-Operative Telephone Company. $600.

CAMDEN, PA.—Standard Wireless Telegraph and Telephone Company. $400,000.

FRANKFORT, KY.—The Cynthiana Telephone Company. Increased from $30,000 to $40,000.

LA FAYETTE, IND.—The Merchants' Electric Light Association; increased from $30,000 to $150,000.

GILLESPIE, ILL.—Gillespie Telephone Company. $5,000. Incorporators: J. C. Steere, J. M. Rodiner and H. R. Williams.

DOVER, DEL.—The Water Motor and Power Company, a Pontiac, Mich., concern, to manufacture motors. $1,000,000.

HELENA, MONT.—The Citizens' Telephone Company. $3,000. Incorporators: Henry J. Schreiner, Blaset Tinsley and others.

GILMER, TEX.—Gilmer Electric Light Company. $4,000. Incorporators: J. F. Croley, T. C. Mitchell and C. H. Buckner.

KEWANEE, ILL.—Independent Electric Light Company. $5,000. Incorporators: G. A. Anthony, J. P. Brady, Julius Vancoutrer.

HARRISBURG, PA.—The Tunkhannock & Wyoming Valley Telephone Company, Centre, Westmoreland and Wyoming counties. Capital, $2,000.

MILAN, ILL.—Western Illinois Electric Railway Company. $15,000 Incorporators: Franklin E. Caldwell, Robert E. Little and Elmer E. Reynolds.

GRANITE CITY, ILL.—Granite City & Venice Light and Power Company, Jersey City, N. J. Capital stock, $100,000. Capital in Illinois, $160,000.

NASHVILLE, TENN.—The Southern Creosote Works. $10,000. Incorporators: D. C. Buntin, Leland Hume, T. D. Webb, J. L. Bland and W. L. Granberry.

JERSEY CITY, N. J.—Vermont Power and Manufacturing Company. $150,000. Incorporators: Kenneth K. McLaren, W. L. Fairchild, Howard K. Wood.

NEWARK, N. J.—The American Gas and Electric Company. $1,000,000. Incorporators: Edward T. Magoffin, Herbert E. Murphy and Alfred G. Brown.

JERSEY CITY, N. J.—Leadville District Railway and Power Company. $100,000. Incorporators: Theodore W. Kloman, Arnold C. Saportas and George E. Griswold.

HILLSBORO, TEX.—Hillsboro Electric Company, Hillsboro. Capital stock, $50,000. Incorporated by M. B. Templeton, Osce Goodwin, W. C. Rose and U. T. Buckner.

BEAUMONT, TEX.—The Tuggle Electric Supply and Construction Company. $25,000. Incorporators: G. W. Tuggle, E. L. Bacon, J. F. Keith I. D. Polk and D. Call.

TRENTON, N. J.—Lima Street Railway Company. Principal office, Jersey City, N. J. Object, transportation. $5,000,000. Incorporators: Charles A. Neville, Henry W. Carter and Charles Bott.

COLUMBUS, OHIO—The Cincinnati & Northeastern Traction Company. $15,000. Incorporators: Dennis Dwyer, Albert Emanuel, Charles D. McCrea, Charles L. McCrea and B. M. Hopkins.

MADISON, IND.—The Madison Lighting Company; $75,000; directors: John H. Brown, George Mayer and Guy H. Powell. The Merchants' Electric Light Association; increased from $30,000 to $150,000.

COLUMBUS, OHIO—The Canton-New Philadelphia Railroad Company, Canton. $600,000. Incorporators: Edward C. Louis, Jeremiah E. Reeves, John C. Welty, Philip L. Saltonstall and Lewis E. Meyers.

ALBANY, N. Y.—The Lower Niagara River Power and Water Supply Company. $5,000,000. Directors: James Bow, James S. Simmons, Fred J. Brown, John F. Lynch and George W. Knox, of Niagara Falls; Marion P. Hatch, of Buffalo, and George E. Green, of Lockport.

ALBANY, N. Y.—The St. Lawrence River Power Company, Massena, St. Lawrence County. $7,000,000. Directors: Henry P. Davison, of Englewood, N. J.; Mark T. Cox, East Orange, N. J.; Samuel E. Potter, William J. Wilson, New York, and Thomas A. Gillespie, Massena.

INDIANAPOLIS, IND.—The Union City, Winchester & Muncie Traction Company, Muncie; capital, $10,000; directors: Charles M. Anderson, vice-president; Walton B. Gebhart, treasurer; John C. Feight, secretary; Ralph E. Deweese, general manager, and Theodore Shockney. Mount Summit Rural Telephone Company, Mount Summit; capital, $10,000.

ALBANY, N. Y.—The West Seneca Light, Heat and Power Company, with principal office in the town of West Seneca. $200,000. To furnish electricity and natural and manufacturing gas in Buffalo and the towns of West Seneca, Hamburg and Cheektowaga, and the villages of Doyle, Depew, Hamburg, Sloan and Blasdell. Directors: Elwood B. Smith, Charles A. Hahl and Harry N. Kraft.

PERSONAL MENTION

MR. W. C. WOODWARD, of Providence, the electrical engineer of the Narragansett Electric Lighting Company, was a New York visitor last week. Mr. Woodward recently recovered from a severe illness.

COLONEL S. G. BOOKER, of St. Louis, has established an office at 405 Fullerton Building, in that city, as manufacturers' agent, and will represent a number of electrical houses. Colonel Booker was for a number of years identified with the manufacture of electric batteries, and is quite widely known in the electrical and allied fields.

INDUSTRIAL ITEMS

W. H. CRUMB, 1263 Monadnock Block, Chicago, is buying material for reconstruction of the telephone exchange at Newark, Ohio.

G. M. GEST, the conduit contractor, has been awarded the contract for the additions to the underground subway system of the Edison Electric Illuminating Company of Brooklyn.

C. J. TOERRING COMPANY, owing to the rapid increase in business, has been compelled to take more extensive premises at Warden Power Building, Nineteenth street and Allegheny avenue, Philadelphia, Pa., which will be its address.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is sending out circulars illustrating and describing the Chapman lightning arrester, and will gladly mail upon application. This arrester is a new and efficient protection for instruments and property generally.

THE HELIOS-UPTON COMPANY, Philadelphia, Pa., has secured an order for a 3,000-ampere battery from the Grand Rapids Edison Company of Grand Rapids, Mich. This is the second large contract for storage batteries secured from Edison central stations by this company, the other contract being for a large battery installed by the Edison company at Kansas City, Mo.

JONES & WINTER, 1259 Monadnock Block, Chicago, finds no stagnation in business for the summer season. The company has contracts and is now erecting a 1,200-line exchange for the People's Independent Telephone Company, Paducah, Ky.; just commenced a 750-line exchange for the Jackson Home Telephone Company, Jackson, Tenn.; a 600-line exchange for the Stephenson County Telephone Company, Freeport, Ill. They are nearly completed and will have in use within the next thirty days a 1,000-line exchange for the Home Telephone Company, Rockford, Ill., and another 1,000-line exchange for the Wichita Telephone Company, Wichita, Kan.

THE AMERICAN STEEL AND WIRE COMPANY, Chicago, New York, Denver, San Francisco and Worcester, issues a very useful book of reference tables of wires for electrical purposes. This embraces a table of dimensions and weights of pure copper wire, a table of comparative sizes, wire gauge in decimals, in which comparisons of the pounds per 1,000 feet of copper wire of the same size numbers of different gauges are given, comparison of the pounds per mile of copper wire of the same size-number of different gauges, table of resistance of pure annealed copper wire and standard copper conductors, table of sizes, weights and length of iron and steel. The rail-bonds manufactured by this company are also described and illustrated, and a number of pages are given up to a list of the products made by this company.

SCIENCE ABSTRACTS, in addition to the regular list of journals used in reviewing, has added the following, making a total at present of about 150; Journal of the Russian Physico-Chemical Society (Russian); Proceedings of Academy of Sciences, Amsterdam (Dutch); Proceedings of Academy of Sciences, Stockholm (Swedish); Proceedings of Academy of Sciences, Christiana (Norwegian); Proceedings of Academy of Sciences, Copenhagen (Danish); Zeitschrift für Anorganischen Chemie, Royal Society of Edinburg Transactions and Proceedings, British Optical Journal, Elettricista (Rome), Iron and Steel Institute Transactions, American Society of Mechanical Engineers Transactions, Engineering and Mining Journal (New York), Power (New York), American Telephone Journal, La France Automobile, Der Motorwagen, Automobile Review (Chicago), Archives of the Rœntgen Ray, and Philosophical Society of Washington Bulletin.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is finding an ever-increasing demand for its various lines of direct-current machinery, and has found necessary a large increase of floor space. A new building, now half way to the roof, will nearly double the present capacity, and by clearing out many small machines in the main shop permit of the placing of new and heavier machinery to accommodate larger sized generators and more rapid work on large orders for the smaller standard machines. The new building is of brick, slow-burning mill construction, three stories in height, and intended for the winding departments and light machine tools. A portion of the basement space will be used for the experimental laboratories, whence emanate the changes in design that maintain the reputation of Crocker-Wheeler apparatus for embodying features which the best of engineering experience approves.

THE ALLIS-CHALMER COMPANY, Chicago, Ill., reports the following important engine sales for June: W. F. Stewart Company, Flint, Mich., 18 x 36-inch, 1890 frame, Reynolds Corliss engine; Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y., 22 x 48-inch, 1890 frame, Reynolds Corliss engine; Brown, Cary & Woodruff Company, Salt Lake City, Utah, 12 x 36-inch, 1890 frame, Reynolds Corliss engine; Tyee Copper Company, Ladysmith, Vancouver Island, 14 x 36-inch, girder frame, Reynolds Corliss engine; Kioto Traction Company, Kioto, Japan, 16 and 32 x 36-inch, 1890 frame, cross-compound, direct-coupled Reynolds Corliss engine; International Paper Company, New York city, N. Y., 16 x 42-inch, 1890 frame, Reynolds Corliss engine; Virginia-Carolina Chemical Company, Richmond, Va., one 16 x 42-inch, girder frame, Reynolds Corliss engine, one 20 x 42-inch, girder frame, Reynolds Corliss engine; Janesville Cement Post Company, Janesville, Wis., 14 x 36-inch, girder frame, Reynolds Corliss engine; Twin City Rapid Transit Company, Minneapolis, Minn., 46 and 94 x 60-inch, vertical, cross-compound, direct-coupled Reynolds Corliss engine (third order); London United Tramways, London, England, 26 and 54 x 48-inch, vertical, cross-compound, direct-coupled Reynolds Corliss engine (second order); Pennsylvania Railroad Company, Pittsburg, Pa., one Riedler air compressor with air cylinders 15 and 24 x 36-inch, driven by cross-compound, non-condensing Corliss engine, with steam cylinder, 14 and 24 x 36 inches.

WESTINGHOUSE, CHURCH, KERR & COMPANY, during the last month, have received a large number of orders for Westinghouse steam engines and turbines, including two of the largest engines in existence for power service. The New York Edison Company has ordered two more 6,000-horse-power Westinghouse vertical three-cylinder compound engines, in addition to the eight engines of this same type now running and under course of erection at its Waterside Station; Stanley Rule and Level Company, New Britain, Ct., one 600-horse-power vertical cross-compound marine-type engine direct-connected to Westinghouse generator for lighting and power work; Baldwin Locomotive Works, Philadelphia, Pa., one 700-horse-power vertical cross-compound marine-type engine, direct-connected to Westinghouse generator for power distribution through the shops. Among the Corliss-type engines for which orders have been received are two 1,000-horse-power cross-compound horizontal Corliss for the Syracuse Railway Construction Company, Auburn, N. Y., and one 3,000-horse-power vertical cross-compound Corliss for driving railway generator in the power-house of the Springfield Street Railway Company, Springfield, Mass.; Illinois Steel Company, South Chicago, Ill., one 1,750-horse-power horizontal cross-compound; Hartford Street Railway Company, Hartford, Ct., a complete engine and generator equipment consisting of one 1,750-horse-power horizontal cross-compound Corliss direct-connected to Westinghouse railway generator and switchboard. Among recent turbine orders are several machines of great power, the 1,000-kilowatt turbo-generator outfits will be installed in the power plant of the DeBeers Consolidated Mines, Limited, South Africa, for lighting and power work. Two 1,000-kilowatt outfits ordered by the Cleveland, Elyria & Western Railway Company will be used for generating power for the railway system, centering in Elyria, Ohio. Three 1,000-kilowatt turbo-generator outfits ordered by the West Penn Railway and Lighting Company for electric lighting and power work. The Roslyn Light and Power Company, Roslyn, L. I., will shortly install two 400-kilowatt turbo-generator units for operating the lighting and railway systems in this district; and the Consolidated Railways, Light and Power Company, Wilmington, N. C., one 400-kilowatt outfit for similar work. One 400-kilowatt unit will form part of the power-house equipment of Johnston Harvester Company, Batavia, N. Y., and the E. F. Goodrich Company, of Akron, Ohio, will install a similar unit; also one of 750-kilowatt capacity for general power distribution and manufacture. The steam loop and Holly gravity return system is being rapidly introduced in a large number of foreign and domestic plants. The steam loop system is designed to return condensed steam from traps, piping, etc., directly to the boiler without the aid of a steam pump. The apparatus is controlled and sold by Westinghouse, Church, Kerr & Company.